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UNITED STATES CIVIL-SERVICE EXAMINATION

Selection of Chief of the Bureau of Chemistry and Soils, United States Department of Agriculture, $6000–$7500 a Year

The United States Civil-Service Commission states that the position of chief of the Bureau of Chemistry and Soils of the Department of Agriculture is vacant, and that, in view of the importance of the position in the whole field of chemical and soil research, and to insure the appointment of a thoroughly qualified man for the work, an unusual method of competition will be followed to fill the vacancy.

Description of Examination.—Instead of the usual form of civil-service examination, the qualifications of candidates will be passed upon by a special board of examiners composed of Dr. A. F. Woods, Director of Research in the Department of Agriculture, Dr. Joseph G. Lipman, Director of the New Jersey Agricultural Experiment Station, and Mr. Frederick W. Brown, Consulting Examiner of the United States Civil-Service Commission. For the purposes of this examination, these men will be examiners of the Civil-Service Commission.

The minimum qualifications for consideration are a Doctor's degree from a college or university of recognized standing, at least ten years' experience in the direction and performance of chemical and soil research of a character to show the required degree of knowledge and ability in both chemistry and soils, administrative capacity of the highest order, and thorough familiarity with the literature of chemistry and soils, and with the activities of scientific and professional organizations and associations concerned with the subjects of chemistry and soils. The applicant must also have a personality which will enable him to deal tactfully with the personnel of the research units to be under his direction, and to enter into successful coöperative relations with other research and administrative agencies.

Duties of the Position.—The duties of the position are to direct and administer the work of the Bureau of Chemistry and Soils carried on by a personnel of approximately 540 persons under an annual appropriation amounting to $1,115,005 for the Fiscal Year 1928; and personally in coöperation with Assistant Chiefs and the respective division leaders to initiate, outline, develop, and direct the various phases of research, demonstration, and service work devolving upon the Bureau under the Agricultural Appropriation and other Acts, and by the direction of the Secretary of Agriculture.

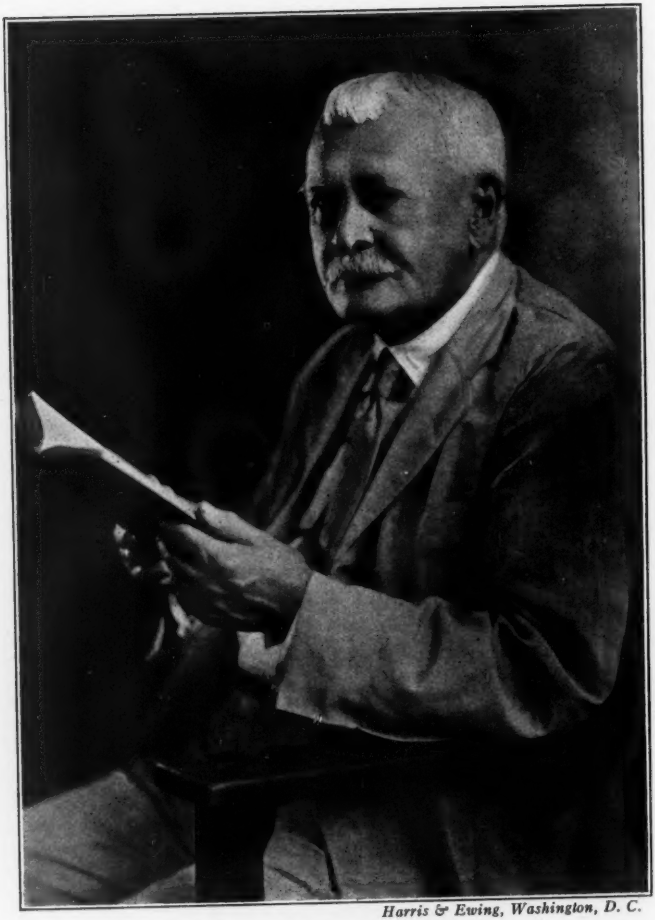
The new Bureau of Chemistry and Soils in the Department of Agriculture is charged with the responsibility for all the research work of the Department on chemistry and soils. In this Bureau there are included the following existing units in the Department:

(1) All of the present Bureau of Soils.

(2) All of the present Bureau of Chemistry, except those units having to do with the enforcement of the Food and Drugs Act, Tea Act, Naval Stores Act, and collaboration with other Departments.

(3) The soil-fertility and soil-bacteriology units of the Bureau of Plant Industry.

Applications.—Qualified persons who wish to be considered for this vacancy should apply to the United States Civil-Service Commission, Washington, D. C., for Form 2600, which must be executed and returned, with a list of the applicant's technical publications and reprints of such of these publications as are available, in time to be on file in the office of the Civil-Service Commission at Washington not later than April 5, 1927.



Harris & Ewing, Washington, D. C.

DR. CHARLES E. MUNROE

EDITOR'S OUTLOOK

DR. MUNROE, whose portrait appears on the opposite page, needs no introduction to American chemists. A bare tabulation of the honors conferred upon him, the offices which he has filled and the organizations in which he holds membership would occupy several pages of the dimensions of this one. The bibliography of his contributions to chemistry, chiefly in the field of explosives, constitutes a pamphlet of respectable proportions in itself.

Dr. Charles E. Munroe

Recalling Dr. Munroe's researches on explosives and his accomplishments in an advisory capacity in this field, one is apt to think of him as a specialist, and rightly so if this is interpreted to mean that he is an unquestioned authority in the branch of the science to which he has devoted much of his attention. Yet, like many leaders who are reckoned specialists, he displays a breadth of knowledge and of interest which belie the connoted limitations of that much-abused term. He exemplifies the principle which we have often sought to emphasize—that the highest and most productive type of specialization is that which consists in the application of extensive learning and versatile abilities to the solution of problems of a particular kind.

While Dr. Munroe is probably most widely known by reason of his scientific and technical achievements, his greatness as an educator should not be underestimated. For more than half a century his charming personality and genius for imparting inspiration and enthusiasm commanded the respect and affection of his students. And throughout that time he contributed to a furtherance of chemical education among the people through his public lectures and writings. He established the first summer school in chemistry at Harvard in 1873 and after his appointment as Dean of the School of Graduate Studies at George Washington in 1893 he became the pioneer in the offering of graduate instruction to employed chemists. Conditions in Washington were particularly well adapted to such a project and a number of the great government experts enlisted in the cause, with the result that excellent courses were given and many able professional men were trained. Today several universities are doing similar work and it is to be hoped that still others will follow.

Dr. Munroe has now retired from the teaching field but he continues his work in connection with the Bureau of Mines and the National Research Council. Many a younger man might envy the vigor with which he "carries on" and the amount of work which he accomplishes.

The Richmond Meeting

ALL advance indications point to a splendid meeting at Richmond during the week of April the eleventh. Secretary Baker reports that titles of papers to be read before the Division of Chemical Education are arriving at a satisfactory rate. Abstracts of some of these papers appear in the Chemical Digest for this month.[1]

Members of the Richmond Section are preparing a program of entertainment which should amply justify the widespread fame of Southern hospitality. Richmond and its surrounding territory are particularly rich in historical associations and in scenic beauty and afford unsurpassed opportunities for sight-seeing excursions. Nor is there any lack of industrial activity to interest the visitor of a more practical turn of mind. One is surprised to learn how many great American industries and public-service projects had their beginnings there.

One of the features of the social program will be a barbecue at Williamsburg. To those who have already had the good fortune to attend one or more of these functions nothing further need be said. Others may confidently look forward to acquiring another unit in liberal education.

The benefits of a more permanent nature which are to be derived from attendance at the meetings of the American Chemical Society are, we believe, too generally conceded to require extended comment. Absentees may, of course, acquaint themselves with the actual contents of papers presented at the meetings through subsequent publications, but they miss the discussions which are frequently as illuminating as the papers themselves and they miss the opportunity to take part in those discussions. How often one would like to have the author of an article at hand to interpret, amplify, or substantiate some doubtful point! Nor are there any substitutes for those informal corridor and luncheon conferences which are frequently so informative and inspiring. As somebody once put it, the question is not "Can you afford to attend?" but "Can you afford to remain away?"

Chemical Publicity

NOT the least characteristic of the phenomena of our modern age is the importance which publicity has assumed in every-day affairs. Time was when the conservative looked upon publicity as partaking of the nature of notoriety—a thing to be avoided as inconsistent with dignity and self-respect. But views have altered; publicity of the proper type is now recognized as an asset and is not only welcomed but may legitimately be sought.

[1] Page 393.

Nowhere is this change in attitude more apparent than among scientists. There are still some who cling to the old ideal of cloistered aloofness and who claim that time spent in talking about one's work is so much time lost from further productive effort. The majority of the more forward-looking, however, recognize the fact that the general public has a keen and genuine curiosity about scientific matters and believe that that curiosity should be met with authentic information. Considerations of enlightened self-interest support this view. Scientific research has outgrown the stage where adequate support may be expected from private sources. An informed and sympathetic public opinion is necessary to its future advancement.

Probably the greater volume of publicity necessary to attain this end will continue to emanate from men who make an occupation of this type of writing. It is apparent, however, that occasions frequently arise in the experience of anyone actively engaged in scientific affairs when publicity is highly desirable but the services of a professional publicity man are not available. In such an event it is very convenient to be able to assume the rôle of reporter. Perhaps the time will come when training in the writing of newspaper articles will supplement, or be included in the usual courses in composition and public speaking which are offered as part of the general education of every college student.

In his paper presented before the Division of Chemical Education at Philadelphia, Mr. Murray[2] set forth the main points to be observed in the preparation of newspaper copy. Most of the advice he offers might be gleaned from any elementary text on journalism. All of it is obviously founded on plain common sense. Nevertheless, we have seen ample evidence that many amateur reporters could profit by it and we recommend a careful reading of "How to Get Chemical Publicity."

Research Institute for Chemical Education

ONE very important item of business awaiting action at the Richmond meeting is the disposition of the tentative plan for a Research Institute for Chemical Education which was published in the January number of THIS JOURNAL.[3] Criticisms and suggestions relative to the plan as first formulated have been widely sought with a view to determining: (1) Whether such a project seemed adapted to the fulfilment of a general need, and (2) how the proposed institute could be made to function to the greatest advantage of the greatest number. The volume and tenor of the response to this appeal for discussion clearly indicate that the consensus of opinion is overwhelmingly

[2] See Page 333.

[3] THIS JOURNAL, **4**, 110–4 (Jan., 1927).

in the affirmative on the first of these points. The second and more difficult question has also elicited an encouraging amount of constructive criticism. It remains to evaluate and supplement these comments and to agree upon definite plans for the future.

It is already evident that such an institute could occupy an absolutely unique position in the scientific and educational worlds. Two features of the tentative plan which set it apart from existing agencies are the type of research it would undertake and the summer sessions which it would offer for teachers.

Regarding the research contemplated it may be said that attention would be given to problems of a purely educational nature, but that the principal aim should be to overcome the long time interval which at present exists between discoveries in pure science and their incorporation into class-room teaching. Few teachers have the time or opportunity to examine the current literature with the careful attention which it deserves and many do not feel qualified to make a critical selection of fundamentally important matter. Incidentally, the question of material to be eliminated from curricula either because of obsolescence or to make room for newer and more important subject-matter, would receive due attention.

The A. C. S. monograph series has done much to put the vast amount of material scattered throughout the literature in compact and available form. These excellent monographs, however, were not primarily designed with a view to the peculiar needs of teachers and they do not perform the function we have described. The service advocated would in no wise duplicate the labor which has been expended upon them. Obviously only a small fraction of the material contained in one of these monographs could be included in chemical curricula. The choice of that fraction and the method of presenting it are matters which call for rare judgment and careful study.

Possibilities for development in the summer sessions of such an institute are too apparent to require extended comment. The opportunity to combine a pleasant vacation with work toward self-improvement and with associations of an inspiring and helpful nature would be attractive to hundreds of teachers. The formulation of definite plans for this feature would not be a difficult matter.

THE UTILIZATION OF GEOTHERMAL POWER IN TUSCANY*

Prince Ginori Conti, 58A, Via Scala, Florence, Italy

The utilization of subterranean heat is a question which has been only recently taken up by students, especially in America, while in my case, as I propose to point out, it has been a work of progressive development which has required a period of many years.

In speaking of the utilization of subterranean heat, one is generally led to consider only one side of the question—the production of power. In other words, subterranean heat is put on the same level as hydraulic power or combustion of fuel. Still, even in these latter cases, something more than mechanical power can be obtained. Water can be used for irrigation purposes and fuel can be distilled instead of being merely burnt; thus valuable by-products which would otherwise have been wasted can be retrieved. This applies still more forcibly in the case of subterranean heat and I venture to submit that the processes applied at Larderello are to be regarded more especially as an attempt at a complete and rational utilization of the volcanic or pseudo-volcanic phenomena by which subterranean heat is brought within our reach.

Volcanoes constitute the most impressive spectacular form of manifestation of our planet's internal energy but it is certainly beyond actual possibilities to attempt the use of such dangerous reservoirs of natural heat. In the neighborhood of active volcanoes there often are, however, zones of minor activity such as *Solfataras*, pertaining to extinct volcanoes, or steam springs on the outskirts of the main volcano. Such is the region of Vesuvius, where we find the *Solfatara* of Pozzuoli and the Phlograecan Fields.

I certainly do not attempt to deny that there is still some risk in "tapping" these zones, but believe that the feat is far from being an impracticable one. Experiments have been made at Pozzuoli and the first were not successful, but I happen to know that the attempt is being renewed, and I confidently hope that this time the outcome will be a different one.

Of course, geysers and *Soffioni* (the latter being the Tuscan name for natural steam springs) are milder and more accessible manifestations and, fortunately, there are several spots on the Earth's surface where such phenomena are known to exist. Such is the case of Tuscany, of California, of Oregon and Yellowstone Park, of the Tatio Springs in Chili, of New Zealand, of the Dutch Indies, and of Japan.

The Tuscan Soffioni

The existence of the Tuscan *Soffioni* was undoubtedly well known many centuries ago. Without discussing the plausibility of allusion to

* Condensed from a lecture delivered before the International Union of Pure and Applied Science at Washington, D. C. September 14, 1926.

them in some verses of Lucretius' "De Natura Rerum," it is a proved fact that, in the 13th century, the *Soffioni* of Lago and of Castelnuovo were known, by the references made to them in the works of the ancient writers, Ristoro d'Arezzo and Ugolino da Montecatini. They are all quoted by old authors of treatises on medicinal springs but, of course, they deal more especially with the therapeutic properties of the waters rather than with the actual phenomena of the *Soffioni*.

Quite a long period of silence follows and it is not until the 18th century that we find the first really important description of the *Soffioni*, which is the work of an eminent Tuscan physician, Doctor Giovanni

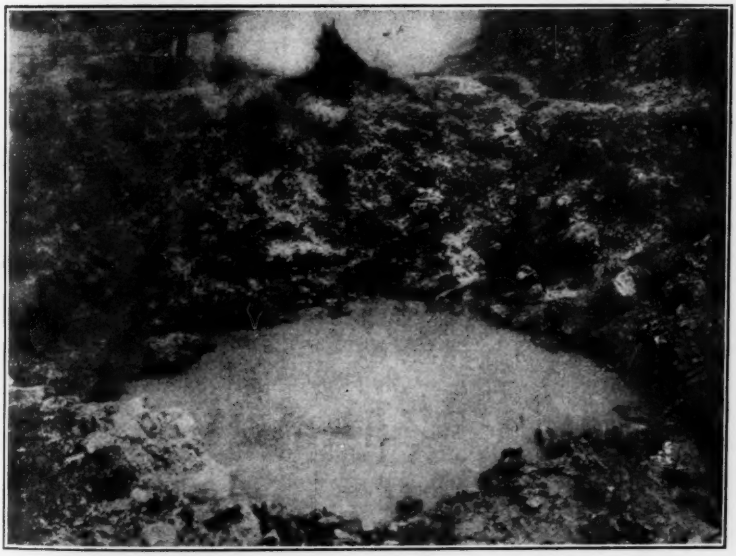
NATURAL STEAM SPRINGS AT LARDERELLO

Targioni Tozzetti, who gives us in his "Viaggi in Toscana," published in 1751, some very interesting details of a visit made by himself to the *Soffioni* and *Lagoni* of Tuscany. Targioni also made some measures of temperature and announces some hypotheses on the composition of the waters of the *Lagoni:* indeed, it would appear that he considered these waters as being worthy of special study.

A few words are necessary here in order to explain the difference between *Soffioni* and *Lagoni*. The name of *Soffioni* applies to the jets of natural steam which escape from crevices in the soil of what we call the "Boraciferous Region" on account of the boron compounds which are

contained in the steam and in the waters of that region. These jets are assembled in groups which are situated, as a rule, at the bases of hills; in many cases they are to be found on opposite sides of the same hill. When these jets have their origin at the bottom of small cavities into which both the waters due to the condensing of the steam and the rain descending from the heights above find their way, we have the *Lagoni* which are small ponds full of hot water and having the appearance of being in a state of ebullition owing to the bubbles of gas which rise to the surface.

Such is the natural appearance of the phenomenon, which is highly picturesque and characteristic, but which is gradually disappearing by



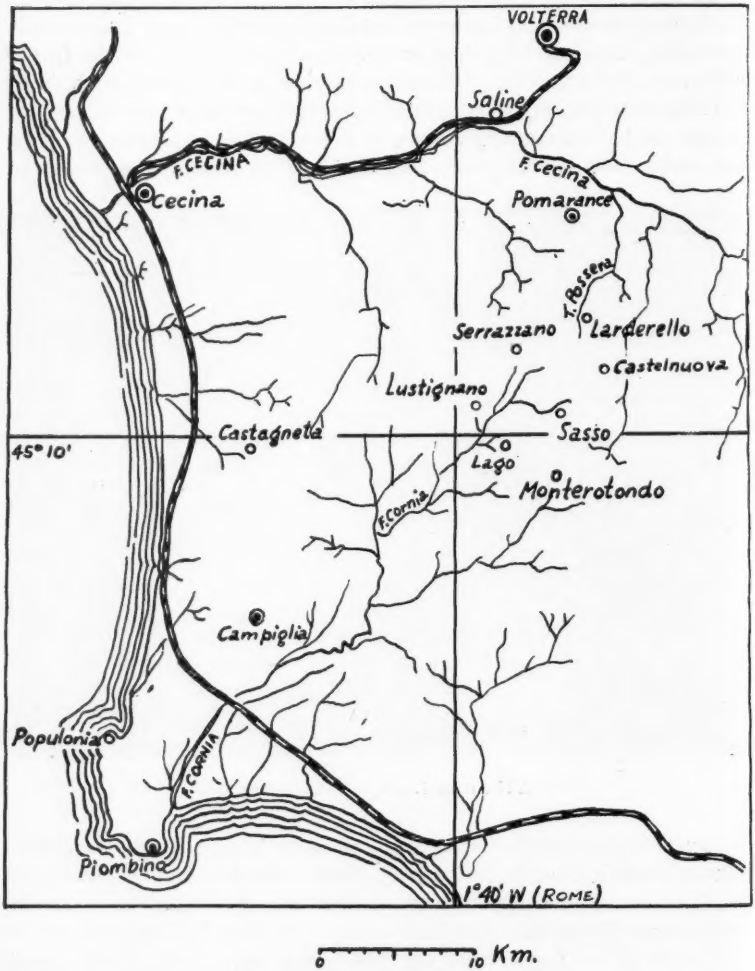
A NATURAL LAGONE AT LARDERELLO

reason of the continual boring of deep wells through which the subterranean steam is brought out by more direct channels, thereby impoverishing the natural and more tortuous fissures through which the steam formerly found its egress.

It was on the *Lagoni* that the first methodical studies and experiments were made by the chemist Hubert Höfer in 1777. Höfer tested the composition of the waters from the Lagone Cerchiaio at Monterotondo, having foreseen a similarity between them and the waters of Stassfurt. His theory proved to be correct and he was able to extract from the water of the *Lagoni*, salt equal to the so-called "sedative salts"

at Stassfurt. This sedative salt was in reality nothing more than boric acid.

Paolo Mascagni, a professor of the University of Siena, and other



MAP OF THE SOFFIONI DISTRICT

scientists followed up the studies of Höfer. The result of their efforts was the birth of the Tuscan boracic industry, which was soon to attain an important development through the strenuous initiative of Francesco De Larderel.

Although the progress of the chemical industry founded on the phenomenon of the *Soffioni* was certainly very considerable, there still remained a further step to take, which was to make use of the natural thermal energy for the production of mechanical power. This step I decided to take as far back as the year 1904, beginning with the tiny plant of a small cylinder engine, and by degrees progressing to that of a larger one, to the turbine of 250-kw. power erected in 1913 and finally to the present large units of 2500 kw.

The Soffioni Region

The *Soffioni* are found in Tuscany in a large area of territory about 100 miles square, on the borders of the Provinces of Pisa, Grosseto, and Siena, situated to the south of Pisa, in close proximity to the Etruscan city of Volterra. This territory contains the hydrographical basin of the two rivers, Cecina and Cornia. The Soffioni are situated in eight different places; of these, three (Larderello, Castelnuovo, and Travale) are situated in the basin of the Cecina, while the others (Sasso, Monterotondo, Lago, Lustignano, and Serrazzano) are in that of the Cornia.

High ridges of hills divide the two basins, which are, in turn, divided into valleys by smaller hills. In these valleys are situated the *Soffioni*.

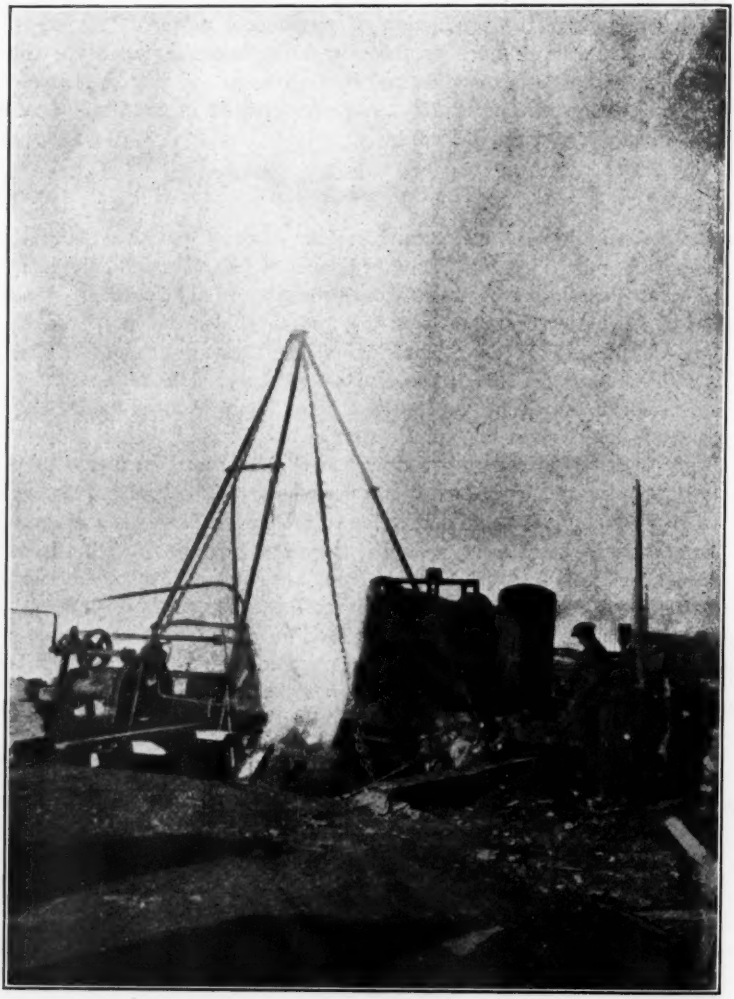
In view of the various and conflicting theories which have been advanced to explain the origin of the *Soffioni* it is evident that the question is still an open one and I myself am far from asserting any decisive theory. The following conclusions may, however, be quite safely expressed as being the result of our daily experiences:

1. That the origin is one and the same for the steam jets which are emitted in the various spots of the Tuscan boracic zone.
2. That this common origin is undoubtedly situated at a very great depth.
3. That there are certain fissures or "faults" in connection with the various localities where the *Soffioni* are situated.
4. That the essential problem, when drilling for steam, is to ascertain the conformation of the undersoil, in such a manner as to be able to choose the spots which are most suitable for drilling in order to arrive, as near as possible, to the aforesaid fissures.

Steam Wells

A detailed description of the methods followed for drilling wells in order to obtain the required amounts of steam for the various needs of the boracic industry, both chemical and mechanical, would be quite out of place here. Such a description, as well as that of the measures and of the studies to be made on the steam, would result in a very tedious

and arid enumeration of experimental data and I consider it best to limit myself to a few remarks of a general character.



ROTARY DRILLINGS AT LARDERELLO

Drilling in the volcanic soil of the *Soffioni* region is now carried out by means of powerful up-to-date machinery, the type generally used being the rotary drill, though percussion drills have not been given up as we

find that, in some cases, very good results can be obtained from them.

The mean diameters of our new wells are about 16 inches and the depths of the wells range from a minimum of 180 feet to a maximum of 750 feet. The wells are all provided with suitable casings made of iron tubes.

Steam begins to appear at varying depths: in some instances at about 45 to 50 feet; in other cases much deeper. A head piece is adapted to the orifice of the well, bearing a horizontal tube through which the steam is diverted so as not to discomfort the workmen on the platform above the well, the rods of the drilling machine passing through an opening in the top head piece. Notwithstanding the above precautions it is quite evident that the work is a particularly hard one and requires experienced hands and additional precautions.

It is very difficult to estimate the amount of time that may be required to obtain a satisfactory output, even allowing that no accidents should occur. With the systems formerly used, it took from two to six months to complete a well. We are now working more rapidly.

The steam increases in violence as the well gets deeper and the drilling is continued until the skilled foremen reckon that no ulterior advantage can be obtained by further work.

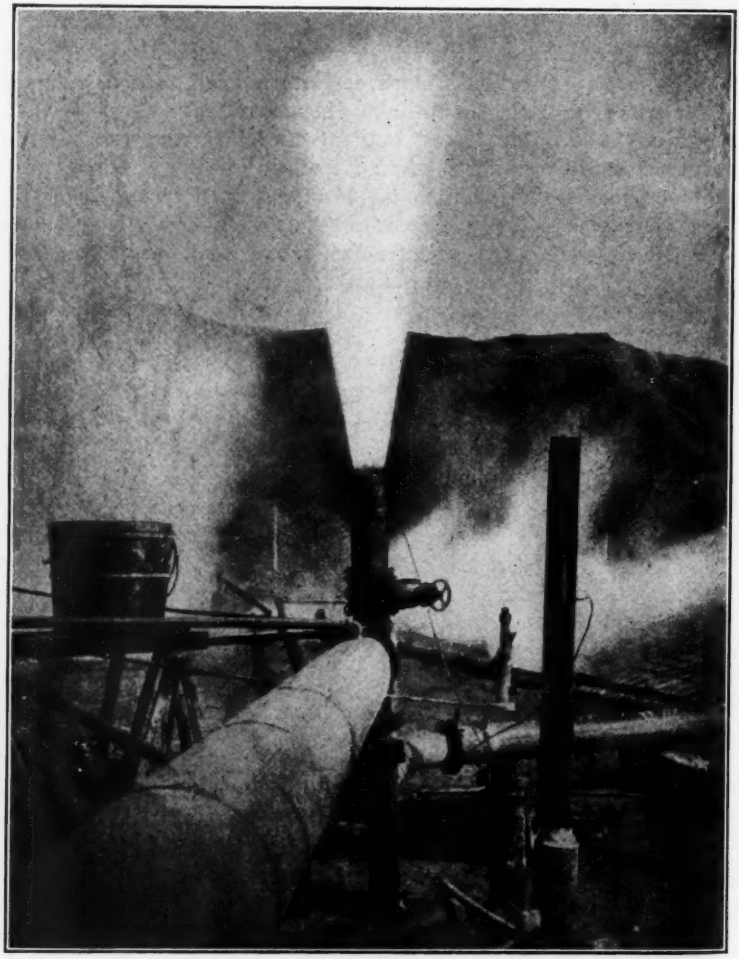
In some instances very little steam comes up for a long time and perhaps none at all, especially if large quantities of water have been found which are exercising a strong pressure against the steam. In such cases a very curious and characteristic operation is performed which bears the local name of *Sfulminazione*. A sort of rough piston is inserted into the tube and then rapidly extracted. If the operation is successful, a small miniature eruption takes place; steam, boiling water, mud, and stones are thrown up during several minutes. Then the eruption quiesces and only steam, which is now free from any counter-pressure of water, etc., is emitted with the characteristic hissing noise of the *Soffioni*.

After the well has been completed, the first operation is to measure its output in steam. This is done by means of a conical gaged tube mounted on the new head piece which is now definitely fitted to the orifice of the well and which is provided with a proper valve for opening or closing the well itself. A mercury manometer reads the pressure of the steam just before it passes through the gaged opening of the conical tube and a simple formula which is an empirical modification of the well-known Saint Vainant formula, gives the steam output.

The experiment is repeated with various gages. Thus it is possible to draw out a diagram giving the various outputs at different pressures and it is interesting to note that these diagrams differ very widely in case of minor wells, the difference being far less pronounced in powerful wells. Several days must be allowed to elapse before a new well can be con-

sidered to have settled to its normal output, the initial period being the most violent.

Difficulties in drilling for steam are numerous owing to abrupt changes



MEASURE OF STEAM OUTPUT

in the quality of the soil and for many other reasons. In some cases little or no steam is found for a long time; then, quite unexpectedly, an explosion may occur, with dangerous results, if proper precautions are not taken.

In the beginning of this year, at Larderello alone, we had a total output in steam averaging over 150,000 kilos per hour, measured at the pressure of two atmospheres absolute. Important outputs were also available at the other works.

The new drillings which have been and are continually being carried out at the various works are giving results which are highly satisfactory. I quote the instance of the "Forconale Well" at Castelnuovo, which has an output of about 60,000 kilos per hour (over 120,000 lb.) at a pressure of two atmospheres absolute. Outputs of 25,000, 30,000, and 40,000 kilos per hour, at that pressure, have become quite normal.

The new wells which we have been drilling have a pressure, when capped, reaching as high as 14 atmospheres absolute which would be about 106 lb. per square inch, and we are able to dispose of very fair outputs at higher pressures than the two atmospheres at which we have been formerly working. The practical effects of this will be shown in describing the new power plants of Castelnuovo. I may add that the steam is naturally superheated in a varying degree when it is emitted from the wells. Iron pipes convey it to the turbine house, the mean length of these pipings, at Larderello, being about 450 feet.

The Utilization of the Soffioni in Chemical Industry

Having treated briefly of the Soffioni from the physical point of view, we will pass on to consider their chemical composition and describe the industry which is founded on the above-stated phenomenon.

As I have already mentioned, the birth of the boracic industry, which claims Francesco De Larderel as its chief founder, followed closely the discovery made by Höfer of the presence of boric acid in the condensed waters of the *Soffioni* steam. It was, in fact, Francesco De Larderel, who, after having initiated in 1918 the manufacture of boric acid by concentrating these waters in vats heated by wood fires, made a complete revolution in the methods used up to that time by abolishing the use of fuel and utilizing in its stead, for heating purposes, the natural steam. This took place in 1827 and our industry intends to commemorate next year (1927) the centenary of this ingenious application.

From this period onward many improvements have been introduced and I think I can affirm without vanity to have myself in these last decades brought a not insignificant contribution to the rational and modern development of the chemical branch of our industry together with my initiative for the utilization of the thermal energy of the *Soffioni*.

Boric acid is contained in varying proportions from one to three per thousand in the waters resulting from the condensation of the natural steam. The process of extraction consists in concentrating these weak

solutions by evaporation, in such a manner that, on cooling, the acid can crystallize. The special feature of this very simple process is the use of natural steam as the means of heating the boric solutions, thus abolishing any necessity for fuel. This application of subterranean heat for industrial purposes, which may be considered as the first in chronological order, is due to the inventive genius of Francesco De Larderel to whom belongs, as I have already said, the merit of having been the real founder of the Tuscan boracic industry.

De Larderel had to overcome many difficulties, considering the scarcity of the means he had at his disposal in his first experiments. It is not my purpose here to enter into particulars but I can assure you that the devices by which he managed to capture the steam from the natural springs (artesian drillings at that time had been scarcely attempted) utilizing at the same time the waters containing the boric acid, were indeed truly ingenious.

Scientific research followed the first empirical experiments; studies were made as to the composition of the steam and the presence of the gases and other substances which are found, beside boric acid, in the steam and in the waters became known. Improvements were gradually introduced and now, as I have already said, we are able to obtain a rational and complete utilization of the steam, both from the chemical and mechanical point of view.

Our principal products are boric acid and its kindred derivatives, such as borax, perborate of soda, and, generally speaking, all boron products which are used in industry.

There are several gases accompanying the steam and among them carbon dioxide prevails. This gas is collected, purified, and compressed. Unfortunately, there is also hydrogen sulfide which appears to be the inevitable accompaniment of all manifestations of a volcanic nature; the proportion is a small one but it is always a disturbing element. There are also helium and argon. Of the former we have been able to separate and collect a certain amount and I intend that studies should be continued in that direction.

In the old days, the natural steam was made to bubble in pools containing water, and in many cases these pools were in the nature of craters at the bottom of which natural steam issued, while other steam was conveyed there by means of iron pipes. These were the so-called *Lagoni* to which I have previously referred.

The boric solution was thus brought to a concentration of about three per thousand and then sent on to the evaporating planes (*Caldaie Adriane*) which are very shallow rectangular tanks of great length made of lead plate. These planes, many of which are still in use, are placed at a certain slope in such a way that the boric waters which are introduced at the

upper end can flow slowly down to the lower extremity. Under the tank there is a large flue in which the natural steam flows, thus heating the evaporating plane and causing evaporation and concentration of the boric waters which are flowing on the plane itself. The steam condenses partially in the flue and thus gives boric waters which can, in their turn, be used for the production of acid. The concentrated liquor is collected in a cooling tank at the bottom of the plane and rational utilization of geothermal energy is being gradually attained.

From what I have said up to now, it is clear that, in order to arrive at a rational and efficient utilization of the natural steam, an accurate study of the conditions under which the aforesaid steam can be obtained, is necessary.

This, however, is only a part of our task, the other being the selection of the most suitable systems, in all respects, for the utilization of the steam obtained from the wells. And now there come into play considerations of a technical and of an economical nature which must be well weighed because, often, the first contrasts with the second. The chemical study of the steam is of great importance in the study of the plant, because upon this depends the greater or lesser necessity of purifying the steam from the presence of the gases which are always a disturbing element of more or less importance according to the systems which are adopted for the utilization of the same.

In the case of our Tuscan *Soffioni*, as I have said before, the gases are present in certain percentages, by weight, which differ according to the various spots where the *Soffioni* are situated, varying from a maximum of 6 per cent to a minimum of 4 per cent. The presence of incondensible gases is, of course, a great hindrance to the efficiency of condensing apparatus in connection with turbines.

In the first 250-kw. plant, and afterwards also for the three units of 2500 kw. which I installed at Larderello, we were obliged to take into consideration the presence of the gases and, therefore, the natural steam was used for heating evaporators which, in their turn, generated pure steam for feeding the turbines.

This system, though theoretically correct, did not answer in a practical way because the water tubes of the evaporators easily got out of order and a communication between the inside and the outside of these tubes was the consequence. The natural steam, containing the gases, entered the turbine and passed into the condenser, greatly reducing the vacuum. The turbines at Larderello are working at a pressure of only *one-quarter of an atmosphere* (1.25 atmospheres absolute) and it will be, therefore, readily appreciated that the smallest reduction in vacuum is bound to lessen considerably the output of the turbine.

The evaporators have been consequently eliminated and we are now

working with a special type of depurating apparatus which is the invention of Signor Bringhenti, who has been for many years my collaborator. This apparatus, a very simple and ingenious device, is based on the different partial tensions of the gases and of the steam. The latter is depurated from the greater part of the gases so that it enters the turbine with about ten per cent only of the original quantity of gases. The gases, in their turn, are sent on to the carbon dioxide plant which I have already mentioned.

A certain amount of water is used in connection with these depurators and this water, being in contact with the natural steam, dissolves the boric acid which the steam contains and gradually arrives at such a degree of concentration as to be suitable for the manufacture of boric acid by means of the evaporating planes or the triple effect apparatus of which I spoke in describing the chemical plant.

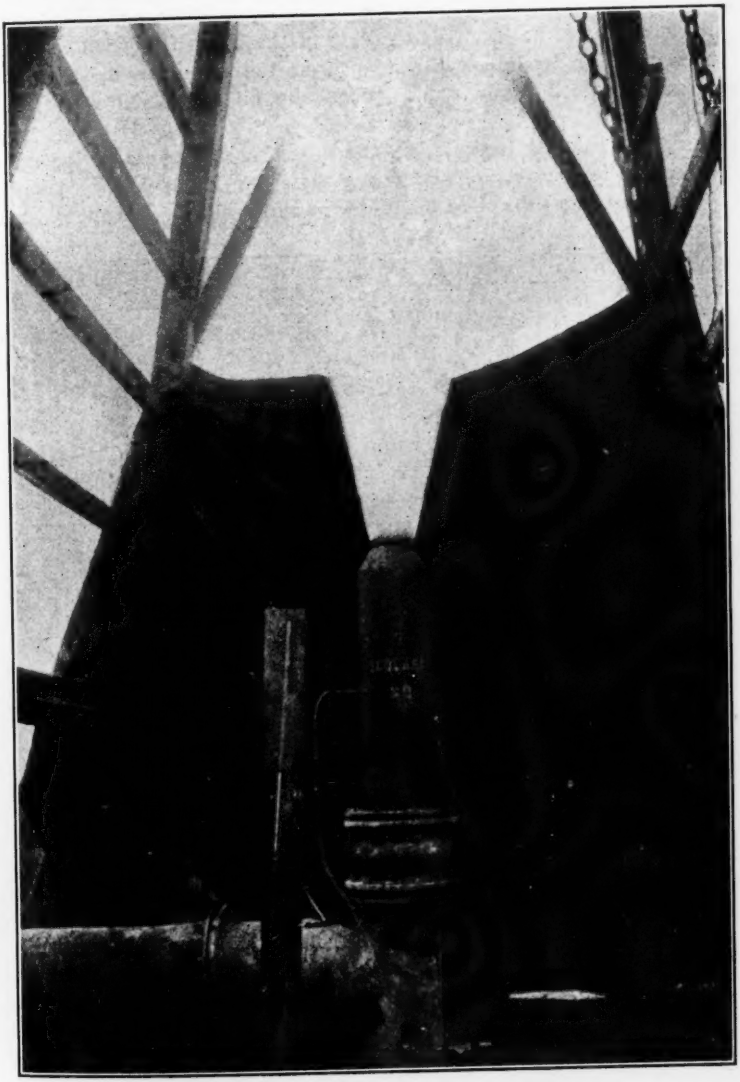
I should also add that the same steam has, in many instances, been made to give up part of its acid *before* it arrives at the Bringhenti depurators at the power house by being, as we term it, *washed*.

This very simple operation is performed by allowing a jet of water to enter the pipes conveying the steam by means of an injector device. The water dissolves a part of the boric acid contained in the steam and is extracted further down along the piping. This operation is not always performed in the case of steam used for power generation, but it is very generally employed in other instances.

When the power plant of Larderello was first begun, there were very few wells that could be considered as really efficient: all the others were small wells, not very deep and of low diameters, which had been drilled many years before with very rudimentary technic. The wells drilled for the power plant represented, certainly, a decided progress, but they are not to be compared with those which are being made now and of which, as I mentioned before, we have some imposing examples. For this reason, we could then only dispose of steam at a lower pressure than we can count upon now, and in fact, in order to obtain a sufficient quantity for our needs from the old wells, it was necessary to have recourse to the lowest pressures. The turbines of the first plant were, therefore, made for a very low pressure: 0.25 atmosphere effective. The condensers first installed were of the surface type and they were afterwards replaced by jet condensers.

The new wells of Castelnuovo and Serrazzano having yielded steam in sufficient quantities when working at higher pressure, I decided to experiment with a free exhaust plant with a 600-kw. unit. We will now compare the two systems.

A turbine with a condenser is theoretically the most perfect and allows a more complete utilization of the steam from a merely thermal point of view. It is well known that with a so-called exhaust turbine and a good

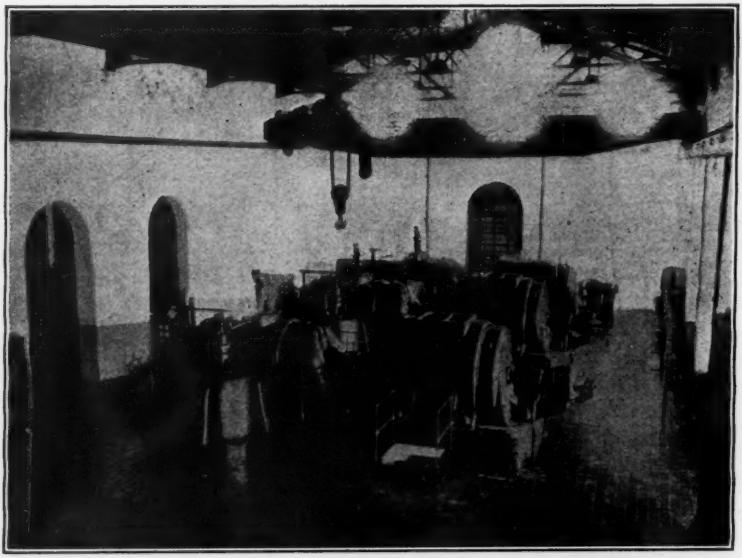


A Powerful Well at Larderello

vacuum in the condenser, comparatively low steam consumptions can be arrived at.

Such a system, however, in the case of the Tuscan *Soffioni*, involves the necessity of depurating the steam from the accompanying gases the presence of which would render practically nil the advantages of the condenser.

With free exhaust turbines, on the other hand, besides having quite eliminated the necessity of depurating the steam, we have a far simpler type of plant less subject to break-downs and requiring less supervision,



INTERIOR OF TURBINE ROOM AT LARDERELLO

besides the advantage of a diminished cost of up-keep. Above all, the cost of installation is decidedly lower.

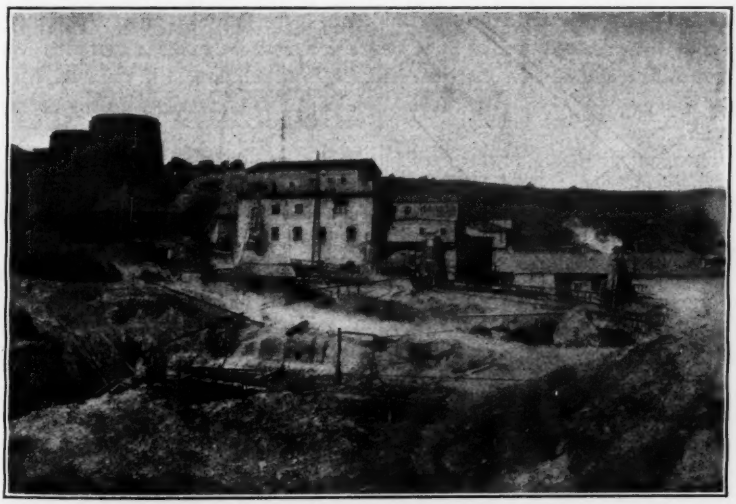
The use of condensers, in those localities where water is scarce, involves the necessity of cooling plants for the condenser circulation systems, hence the need of erecting cooling towers. Three very large ones have been installed at Larderello, each tower dealing with 4500 cubic meters, or about one million gallons of water per hour. They are imposing structures and, therefore, very costly ones, besides needing considerable up-keep.

Condensers besides have various inconveniences, whether they be of the surface or of the jet type. All those who have had some experience

with turbine work know what troubles with the condenser tubes mean. With jet condensers, the air pumps often get out of order.

Working at high pressures, condenser troubles are, of course, far less disturbing, but when, as in our case at Larderello, it is necessary to work at very low pressures, every fault in the condenser has a considerable effect on the efficiency of the turbine.

It must also be taken into consideration that the cost of a free exhaust plant, in which the steam of the wells is in direct communication with the turbine, without any intermediate apparatus, is reduced to the sole expense of the turbine. The complicated systems of condensers, air pumps and water pumps, piping for cooling water, cooling towers, etc.,



VIEW OF LARDERELLO POWER STATION

are completely eliminated, thus doing away with considerable expense both for installation and for up-keep.

Let us now compare steam consumption for the two different cases. With low-pressure turbines having condenser plants, about 20 kilos or 44 lb. of natural steam are required per kilowatt hour. However, this amount increases practically as a consequence of the wearing down of the different parts of the turbine. Still 20 kilos can be taken as a very fair average mean consumption.

On the other hand, if the steam has a pressure of two atmospheres eff. (or about 28 lb. per square inch) and a free exhaust turbine of the impulse type (with only two wheels) is used, steam consumption can

average something like 35 kilos per kilowatt hour, that is to say, about 78 lb.

This steam consumption is not a negligible amount but, on the other hand, as I said before, the cost of installation of the plant is low and the expenses of up-keep are reduced to a minimum.

In the special case of the *Soffioni* from which boric acid is extracted, a free exhaust turbine allows a far better and more complete utilization of the steam from a chemical point of view.

The Larderello plan has been the first experiment for utilizing natural thermal energy and, therefore, it represents a summary of the various phases which it has been necessary to pass through in order to arrive at the most satisfactory solution of this fascinating problem. We have been taught much and continue indeed to learn daily through experience, so that the construction of new plants can now be undertaken with less expenditure and always better results. I myself am still engaged with new schemes for the better utilization of the subterranean riches of the boracic zone.

The Central Electric Station of Larderello could be completed by adding a fourth unit of 2500 kw. to the first three which have been working since 1916. At Castelnuovo, two other units of 650 kw. have just been ordered; these are, of course, of the free exhaust type I mentioned before.

As I have already said, I am favorable to the use of free exhaust units of medium power. These machines can be easily moved, which is a consideration to be valued in the case of geothermal plants. In the case of power schemes, relating to extensive volcanic zones, it might be advisable to install several small power stations of the automatic or semi-automatic type, as has been done with success with hydro-electric plants of medium power which are situated in a near neighborhood to each other for the complete utilization of a given water course.

Other spots which will probably give excellent results are the Works of Serrazzano and Sasso. At Lago there already exists a small plant with a 250-kw. unit which was the one originally installed at Larderello in 1913. There, also, the plant could be considerably increased.

Everything, therefore, leads me to believe that the zone of the boracic *Soffioni* will allow us to obtain a total of power which can be estimated, with prudent foresight, at about 20,000 kw.

* * *

From what I have endeavored to set forth, I trust I have made clear that we have succeeded in utilizing our natural steam to its utmost possibilities so that power may be considered as a by-product of our chemical industry or vice-versa.

This brings me back to my original starting point, and, therefore, to repeat my statement regarding the utilization of subterranean or volcanic steam.

Progress consists essentially in fostering economy. Economy of power and of prime matters must be the aim of modern industry and, therefore, in making use of subterranean energies, the enterprising engineer should, according to my opinion, carefully study and not overlook any of the possibilities contained in schemes of this nature.

Of course, all considerations must be very carefully taken into account and local conditions may very considerably influence development schemes. Still, the fact remains that, by using volcanic steam, we are handling, besides water, other substances which might be usefully employed. It is, therefore, the duty of the engineer to consider the position with all possible care and to call the expert chemist to collaborate.

Chemistry has become the leading science in our civilized world: physics and engineering are her allies. Here we have one of the most evident instances in which the collaboration of the engineer with the chemist is necessary: I might indeed add that it is indispensable.

I do not delude myself as to the difficulties, always considerable and sometimes very great, which have to be overcome in order to be able to harness the most tractable of the manifestations of old Pluto's activity, nor do I deny that the pardonable optimism of an old pioneer may induce me, perhaps, to hope for too much. Still I repeat once again my firm faith in this form of utilization of natural energies which lies before us in the future.

Finds X-Raying Seeds Improves Crop Yield. X-ray treatment of seeds, hitherto regarded as invariably harmful in its effects, is now declared beneficial by Dr. M. Jacobson, a plant physiologist of Camden, N. J., who claims that he has obtained greatly increased yields from seeds subjected to mild doses of "soft" X-rays. The difficulty with the earlier experiments, he states, has been that the rays were used in the harmful "hard" wave-lengths, or that the exposure was continued too long.

In one series of experiments which he reports, potted plants grown from rayed seeds grew faster and more vigorously than those grown from unrayed seeds, they flowered and fruited from one to three weeks earlier, and their yield was from 15 to 170 per cent greater, the fruits being always more numerous and often larger individually.

Seeds were not the only things that benefitted by X-ray treatment, Dr. Jacobson says. Potatoes raised from treated tubers gave, in three separate field tests, increases in crops of 35, 107, and 170 per cent over plantings of untreated tubers. Further tests showed that light has an unfavorable effect on X-rayed tubers and bulbs, which the experimenter states should be protected from the sun after raying if large increases in yield are to be obtained. Time, however, seems to have little effect in diminishing the effect of the raying, for seeds and potato tubers kept for as much as three months after treatment yielded almost as well as did those planted immediately after exposure to the rays.—*Science Service*

THE CHEMISTRY OF PHOTOGRAPHY. I. HISTORICAL CONSIDERATIONS

S. E. SHEPPARD, EASTMAN KODAK CO., ROCHESTER, NEW YORK

Modern photography, taken in its widest sense and including photomechanical reproduction and cinematography, is a human art which started in optical discoveries and inventions, was made practical long after this inception by photochemical discovery, and has been brought to its present triumphs by conjoint developments in optics, chemistry, and mechanics. The long delay between the invention of the *camera obscura* and the first practicable photographic process is not without interest. It is as if the body lay a long time awaiting the animating soul. This delay should give chemists "furiously to think"—to ask themselves whether a like situation has again developed. The importance of the art of photography to civilization is comparable to that of printing. Printing revolutionized society by infinitely widening its cultural basis. It multiplied at will the symbols of thought. Photography has on the contrary multiplied at will the visual representation of fact—and fiction! And this process has been so continued that, in cinematography, movement has been added, while at the present time we are seeing experiments leading to the addition of color, of plastic relief, and of the spoken word to still further strengthen the liveliness of the pictorial representation. Moreover, just as the intervention of mechanics in photographic evolution produced cinematography, so now the intervention of electrical developments is leading to the wired and wireless transmission of pictures across continents and oceans.

In briefly surveying the history of photographic chemistry the chemist will advisably consider whether his chief contribution to photography has been made once for all, or whether mechanics and that new metachemical science, atomistics, are to supplant him.

In glancing backward toward the sources of the present broad stream of photographic evolution we encounter a fact common in the history of invention. It is impossible to rightly designate any one person as the inventor of photography, although attempts have been made to do so. Anyone who has ever traced a river to its "source" will remember how many little rills diverge as the stream is followed backward and upward, and how at last more than one spring or even damp patch of earth may be claimed as the one true source. No more easy is it to fix the exact source of a stream of invention. Of early discoveries leading to photography there might be mentioned the preparation of silver nitrate crystals (by the solution of metallic silver in nitric acid) described in the probably apocryphal writings of the Arabian alchemist, Geber. Although silver is the bedrock of modern photography, it has to spend much of its time

in company with one or the other of the halogens, chlorine, bromine, and iodine. Precipitated silver chloride was known to the alchemist, Basil

BAPTISTA DELLA PORTA

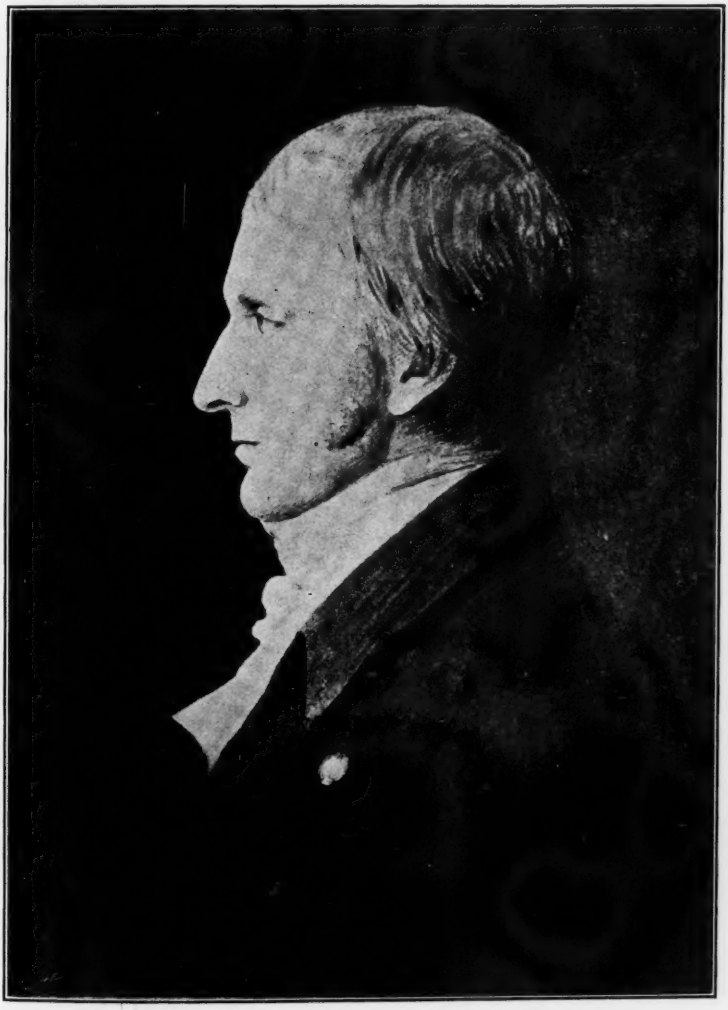
Valentine, while mineral silver chloride (horn silver) was first described by Fabricius in 1565. Thus a fundamental material of photography was already known at a date very near that of the first published description

of the *camera obscura*. For although Leonardo da Vinci (1452–1519) had described in his manuscripts, as though already known, the combination of a dark chamber and a pin-hole by which a real image of an external scene could be thrown upon a flat surface, yet the first published description of this was made by Baptista della Porta in 1558, and the earliest mention of a camera with a lens is in 1568 by Daniello Barbaro. Thus at about the same time the optical instrument and a fundamental chemical material necessary for photography were available. But it was nearly three hundred years before these were brought together in a practical photographic procedure. It was not, indeed, until 1727 that J. H. Schulze, born in Coblitz, Germany, definitely observed and recorded that silver nitrate mixed with chalk was darkened by light, and made fugitive copies of stenciled letters with this mixture. By virtue of this discovery Schulze has been acclaimed as the inventor of photography. This claim appears to be excessive. The invention of photography required that the discoveries by chemists of the light sensitiveness of silver salts (and of other materials) be united with the invention of the *camera obscura* to fix the images produced in this. Schulze does not seem to have had even an idea of doing such a thing, but his discovery led by way of a repetition of his experiments made by Dr. Lewis in England in 1760 to the inception of photography by Thomas Wedgwood. This latter, the son of Wedgwood, the celebrated potter, conceived the definite idea of fixing images in the *camera obscura* by the action of light upon paper or leather treated with silver nitrate. His experiments are described in an article upon "Copying of Paintings upon Glass and of Making Profiles by the Agency of Light by Nitrate of Silver," which was presented by T. Wedgwood and Sir Humphry Davy, to the *Journal of the Royal Institution* for 1802. Wedgwood also has been termed the first photographer and certainly definitely conceived the idea of photography. He was, however, unable to secure sufficient sensitivity to copy images in the camera in a reasonable time, and he was unable also to chemically fix the image so that it should not be destroyed by future action of light. We have here, therefore, the idea of photography, but the event is still delayed.

Early Photochemistry

If the experiments of Schulze were probably those which led to Wedgwood's attempts, it was the more important researches and discoveries of Scheele, the great Swedish chemist, in 1777, which led to the fuller development of photochemistry as a science and which fertilized at numberless points the later progress of photographic invention. Scheele discovered the photochemical decomposition of silver chloride, definitely attributing the darkening to the action of light and showing analytically

that the material was decomposed to silver with loss of chlorine.[1] He further tested the action of the spectrum and showed that the violet-rays



THOMAS WEDGWOOD

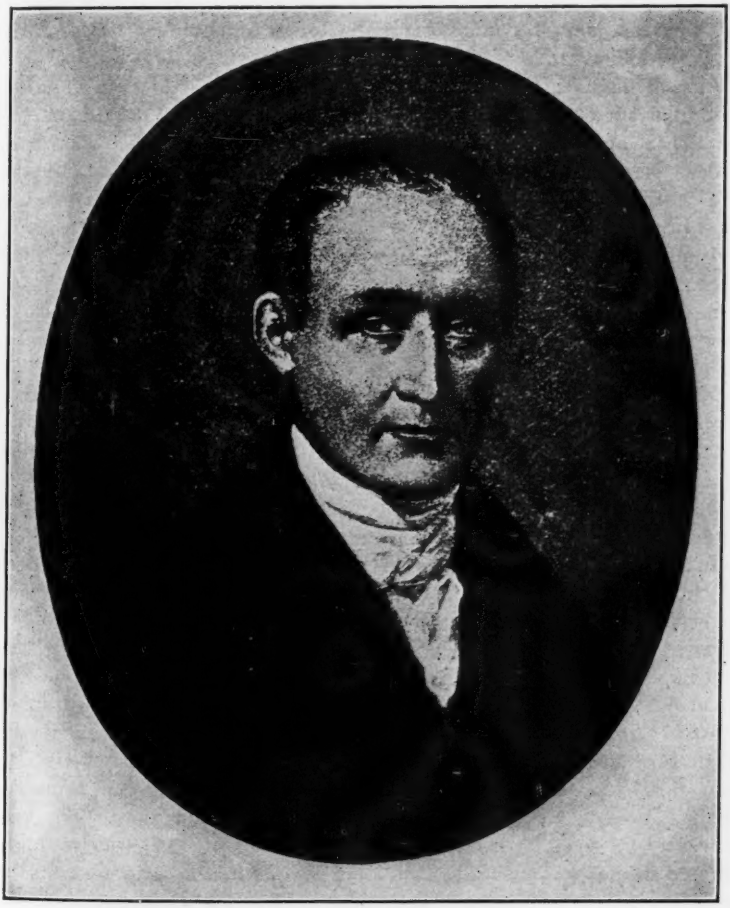
[1] Scheele says "So viel als jedes Theilchen des Hornsilbers auf seiner Oberfläche in Silber verkehret wird, das auch eben so viel Salzsäure sich scheiden muss." (Über Luft und Feuer.)

were more active than the red. Scheele should be regarded as the founder of the photochemistry of silver salts, and the end of the 18th century and the beginning of the 19th showed a large and increasing number of observations on the chemical activity of light. Bergmann, 1779, Senebier, 1782, and Mrs. Fulham, 1794, continued the study of silver salts, while Bergmann and others also observed the changes produced by light in mercury salts. It is remarked by an historian of photography,[2] almost with exasperation—"Parmi tant de patients, savants et avides chercheurs on n'en trouve aucun qui fait mention d'un procédé de dessin reproduçant la nature." While another historian comments on the failure of the alchemists to make practical application of their discoveries. Does not such criticism misconceive the historical relation of discovery to invention? Discovery, the field of science, is an effort directed backward to unveil the past, the accomplished fact which is alone susceptible of scientific examination. In a sense, invention was originally a by-product of this effort, nor could it be expected that the first discoverers would recognize that this by-product was to be at once the most important outcome of their efforts and the essential means for their further prosecution. We live forward to understand backward, we invent the future to discover the past. Each genuine invention provides again tools for the furtherance of this discovery, and few have done more so than photography. It is not, perhaps, surprising that photography had to await the period of the industrial revolution in the early 19th century to grow to full vigor, and to secure the necessary conjunction of invention with discovery.

Wedgwood's attempt appears as a solitary germ of inventive thought during a period when photochemical discovery was being widely extended. For, in addition to the observations on silver and mercury salts, there began to be noticed by de Saussure, Senebier, and others the bleaching of vegetable dyes by light, and by Döbereiner the photochemical reaction of iron salts. Vauquelin in 1798 had discovered chromium and chromic acid, but the light sensitivity of chromated organic colloids was first recorded by Suckow in 1830. Much more important for photochemistry was the discovery by Ritter of ultra-violet rays in 1801, which was to furnish later a most active field for photochemistry and a great extension of the scope of photography. It may be said that the germ of color photography was isolated in 1810 by Seebeck's experiments on the action of the spectrum on silver chloride. He discovered the existence of color adaption, the capacity of light-affected silver chloride to reproduce, albeit imperfectly, the color of the incident light. For this he has been termed by J. M. Eder, "The discoverer of photography in natural colors," but this is excessive and logically incorrect. Seebeck made no application of his *discov-*

[2] G. Pottonié, "Histoire de la Découverte de la Photographie," P. Montel, Paris, 1924, p. 61.

ery to the production of images colored in the camera, and the first *inventions* of photography in natural color are of much later date than Seebeck and only one of the processes evolved has any connection with his discovery.



JOSEPH NICEPHORE NIÉPCE

A Transition Period

The end of the 18th and the first years of the 19th centuries form a natural transition period from the era of photochemical discovery to that of photographic invention. As we noticed, Wedgwood's attempt in 1802 was no more than a faint shadow of the coming event.

The Emergence of Photography

The first man to obtain a permanent photograph was Joseph Nicephore Niépce, born at Chalons in France in 1765. Niépce, a man of ingenious mind, was attracted to lithography, only recently invented, and introduced in France in 1813. It was his object to save lithographers the work of copying designs on the stones by imprinting such designs through the agency of light. Already in 1813 he experimented with silver chloride, with guaiacum, and even with phosphorous, but not until 1826 did he find a material at all amenable to his needs. This was so-called "Balm of Judea" or bitumen. This material, originally soluble in oil of lavender and other essential oils, becomes insoluble when exposed to light, so that after printing under a line drawing on a metal plate covered with asphalt, the unprotected part, *e. g.*, the lines, can be dissolved out. The lines then may be etched out in an acid bath, the undissolved asphalt acting as a resist. Niépce thus produced the original of all photomechanical or reproduction processes, and at the same time the first permanent photograph.

While Niépce had made a great advance in principle for photomechanical reproduction the advance in fact relative to photography was but slight. The exposures required by this process were enormous, being of the order of at least six to ten hours in bright sunlight, and the appearance of these "heliographs" was very flat and lacking in contrast and detail. We meet, however, in the invention of photography, with a parallel to chemical induction, in which one chemical reaction stimulates another. At the time of Niépce's efforts, the problem of photography was envisaged and attacked by Daguerre,[3] an ambitious and gifted scene painter, who had devoted his talent to the diorama,[4] that inanimate predecessor of the cinema. Daguerre, having used the *camera obscura* in his profession, dreamed of producing such images by the sole automatic action of light. Up to 1826 he worked with but little success and apparently in a very haphazard fashion. In that year he heard of Niépce's work and wrote to him, but Niépce was suspicious and did not answer. In 1827 Daguerre again addressed Niépce and obtained a non-committal reply. This led, however, to several personal interviews and about 1830 the inventors entered into a partnership for the joint prosecution of their work. This was terminated by Niépce's death in 1833, but the partnership was renewed by Daguerre and Isidore Niépce, the son, in 1837. In this interval Daguerre had made the epochal discovery that a still invisible image on silver iodide, exposed in the camera, could be made visible, or developed,

[3] Born at Cormeilles near Paris in 1787.

[4] Concerning which Lincoln made his famous remark when asked his opinion thereof, "That for people who liked that sort of thing it was just the sort of thing they liked."

by fuming the silver iodide with mercury vapor. The inventions of Niépce and of Daguerre were published to the world simultaneously by the French

L. J. M. DAGUERRE

Home Minister in a bill presented to the House of Deputies proposing a National Reward to the inventors. A full description of their methods

was presented somewhat later on August 10, 1839, at a meeting of the Academy of Arts and Sciences.

The publication of Niépce's and Daguerre's success had two immediate results. The first was a mild furore of interest in the new invention of

HENRY FOX TALBOT

Daguerreotype, leading to certain improvements to be noted later. More important was its effect in causing another inventor in this field to immediately proceed to publication of his results. This was Henry Fox Talbot,[5]

[5] Born February, 1800.

an English amateur of science who already, between 1826 and 1834, had published several papers on various optical phenomena. It was in 1833, in attempting to sketch first by the aid of the *camera lucida* and then by the *camera obscura*, that the idea of photography took possession of him. Six years of work succeeded, and an advance rumor of Daguerre's success caused him to have his new method of "Photogenic Drawing" expounded by Faraday before the Royal Institution on January 25, 1839. A paper giving a full description of the method was published shortly after in the *Philosophical Magazine* and actually preceded the publication by Daguerre.

In its ultimate importance Talbot's invention was of much greater consequence than that of Daguerre. Talbot had continued the work of Wedgwood of sensitizing paper, but had vastly improved it by precipitating silver chloride in and on the paper and leaving it sensitized with excess of silver nitrate. In this way he was able to greatly reduce the exposure and could obtain in about an hour a picture in a camera. Further he overcame the want of a fixing agent experienced by Wedgwood, removing the excess silver chloride by washing out with a solution of common salt, or one of potassium bromide or iodide. He thus took advantage of the solubility of silver halides in excess of alkaline halide solution, a reaction of fundamental importance for the photographic process. These "calotypes"[6] were printed out by light, but in 1840 Talbot discovered the latent image and that it could be developed by brushing the sensitive paper with a mixture of gallic acid and silver.

It is interesting to note how the developing action of gallic acid and soluble silver salt was independently discovered by the Rev. J. B. Reade and, indeed, at a slightly earlier date. Reade had confirmed Wedgwood's observation that leather gave a more sensitive support for silver salts than paper. He confiscated his wife's stock of white kid gloves for this purpose and the matrimonial discord ensuing led him to the discovery that the increased sensitiveness to light was due to the nut galls used in tanning the leather. He, therefore, obtained the principal extract from the galls, gallic acid, and found a substance capable of developing up the latent image by a selective reduction of a silver salt by this image. Reade's work on this led to a dispute when Talbot patented his process in 1841, but Talbot's patent was upheld, because Reade had not properly published his discovery prior to Talbot.

The execution of a Daguerreotype, or even the attainment of a relatively poor image, demands the closest attention and considerable skill. A smooth silver plate, or copper heavily plated with silver, is buffed and burnished as near as possible to a perfect mirror. The silver is then iodized by a very careful fuming with iodine, generally mixed with

[6] "Beautiful pictures."

some bromine, and this iodizing must produce a film of silver iodide of the most tenuous yet uniform character. The determination of the correct exposure is a matter of very great difficulty. It is followed by the process of development with mercury vapor, where again infinite precaution and great care are necessary. The resulting image is of the most delicate and fragile character, although unsurpassed in what is now termed resolving power, that is, rendering of fine detail. Its chemical stability may be improved by gilding, that is, amalgamating with gold from a gold reducing bath, and its mechanical fragility by varnishing. It is, however, in any event, a very difficult process, and one not easy of demonstration. On the contrary anyone can prepare with ordinary precaution, a sensitized paper such as used in calotype or talbotype. A close, even-grained paper should be selected, brushed over one side with a solution of silver nitrate containing 7 grams to 200 cc. water. The paper is allowed to dry and then dipped in a solution of potassium iodide, 35 grams to 500 cc. In about two to three minutes the silver should be converted to silver iodide. The paper is then rinsed and dried, and in this condition is relatively insensitive. For use it is taken into a dry room and brushed over with "gallonitrate of silver," being a solution of silver nitrate (10 per cent) with $^1/_6$ its volume of concentrated acetic acid together with an equal quantity of a saturated solution of gallic acid. The paper may be used wet, or kept dry for future use. In either case, after exposure, the picture is developed up by brushing some more of the "gallo-nitrate of silver" over the exposed surface. It is then washed and the excess silver halide fixed out by a strong solution of hypo (thiosulfate of soda).

The developed image on a sheet of calotype paper was the exact reverse, as far as light and shade were concerned, of the original image. Such a picture was termed by Sir J. Herschel in 1841 a negative. Paper being a semi-transparent substance whose transparency could be increased by waxing or oiling on the reversed side to the image, Talbot was able to obtain true copies or positives of any negative by simple contact printing upon another piece of sensitized paper. Talbot's process should be considered as the first stage in the real line of photographic development, the notable inventions of Daguerre and Niépce being only by-paths whose chief importance was the mental stimulus they gave to photographic evolution.

From Talbotype to the Dry Plate

The threshold of photography had been achieved by Talbot and we have but brief space to consider historically subsequent outstanding improvements. It is evident that the paper in Talbot's process is both a mechanical support and a binding medium for the insoluble silver salt, and is not ideal for either purpose. An advance was made by Niépce de

Saint Victor,[7] who tried an albumen film containing silver iodide coating on glass in 1848. In the same year Scott Archer introduced, in England, collodion on glass. Collodion, a solution of nitrocotton in a mixture of ether and alcohol was first prepared by Maynard of Boston, U. S. A., in 1847, the year following the discovery of nitrocellulose by Schoenbein. Its photographic application now followed rapidly upon the discovery of the material. To a solution of pyroxylin in ether and alcohol, Archer added a soluble iodide, usually with the addition of a little bromide, and coated a clean glass plate with the iodized collodion. In the dark-room the iodized collodion was sensitized by immersion in a bath of silver nitrate, forming silver iodide with excess of silver nitrate. The plate was exposed wet in the camera, developed by pouring on a mixture of water, acetic acid, and pyrogallic acid and fixed with a strong solution of "hyposulfite of soda" for which cyanide of potassium was later substituted. Archer's collodion process was not patented and in three or four years practically displaced both calotype and Daguerreotype. As a standard of comparison a photographic historian says that "about 1858 the camera became as common an object as a barrel-organ." The messiness of the process, however, caused the popularity of photography to increase but slowly among amateurs, but coincident with its arrival we may note the development of professional photography and the founding of The Photographic Society of Great Britain in 1853 and of two weekly periodicals, the *Photographic News* in 1858 and the *British Journal of Photography* in 1854. The inconvenience of the wet plate process led to many attempts to prepare dry collodion plates which would necessitate no extensive equipment in the field, and would lessen the trouble in the dark-room. This involved many experiments in the direction of adding hygroscopic substances to the collodion to prevent its becoming horny and impenetrable. It was further found necessary to wash out excess silver nitrate to make the plates keep and various, one may say innumerable, substances were added as so-called preservatives. Such substances had at least two principal functions, they retained the permeability of the collodion and they acted as chemical sensitizers in place of silver nitrate by absorbing the halogen formed during the exposure. Among the preservatives used may be mentioned gelatin, glue, honey, dextrin, vinegar, beer, morphine, tea, coffee, and tobacco. It is noteworthy that practically none of the dry collodion plates were anything like as rapid as the wet plates. This search for dry plates led to the collodion emulsion process in which, instead of the silver iodide being formed by treating the plate with silver nitrate, the silver nitrate was precipitated in a finely divided form in the collodion before coating. Still further improvement in the keeping properties of collodion emulsion were made by slight acidification and washing out

[7] Nephew of Nicephore de Niépce.

the excess salts before coating, although it was frequently found desirable after coating and before exposing to soak the plate "in a flat bitter beer to which a little pyrogallic acid had been added." Collodion emulsion was a practical advance on wet collodion but involved no improvement in the matter of sensitivity. Fundamental contributions to this were made by the introduction of alkaline development by Maj. Russell in 1862, by which a considerable increase of sensitiveness was obtained with collodion emulsion, but the full fruit of which was only reaped with the introduction of gelatino-silver bromide dry plates.

Gelatin Emulsion and the Modern Period

The modern industry of photography only became possible with the introduction of gelatin as the suspending medium for the silver salt, made by Dr. R. L. Maddox of Liverpool in 1871. Maddox himself was unable to follow up his invention but he was followed by a number of experimenters, among whom may be mentioned J. Burgess and J. Kennett, who attempted to sell commercial dry gelatin emulsion and coated plates. It is curious to note that one of the chief reasons for early failures was the relatively high sensitivity. Experience with dry collodion plates had made it inconceivable to photographers that dry plates could be made more rapid than a wet plate. Yet great as was the increase of sensitivity which was obtained by mere substitution of gelatin for collodion this was to be even surpassed by the process of cooking the emulsion first described by Bennett and by Col. Stuart-Wortley in 1878. We shall return again to the chemistry of the cooking process, but may note that similar results were obtained by Monkhoven by the use of ammonia.

It is interesting at this point to record the advance made in photography in terms of the relative sensitivity of the process.

Process	Date	Time of exposure
Heliography	1827	6 hours
Daguerreotype	1839	30 minutes
Talbotype	1841	3 minutes
Wet Collodion	1851	10 seconds
Collodion emulsion	1864	15 seconds
Gelatin emulsion	1878	1 to $^1/_{200}$ second
Gelatin	1900	1/1000 second

It is the tremendous increase in sensitivity which has made possible the great modern photographic industry and, more particularly, its use by amateurs and its development into cinematography. An advance of equal importance with the introduction of gelatin was initiated in 1873 by Prof. H. W. Vogel of Berlin who made the extremely important discovery of color sensitizers or optical sensitizers, that is, the use of certain dyes in very small amounts to widen spectral sensitivity of the silver

halides. The accompanying figure,[8] illustrates the advance made in widening this spectral range since 1875. It is this discovery of Vogel's which really made possible such achievements as have yet been made in color photography, while its scientific importance for the spectroscopist cannot be over-estimated. We see here how the organic chemist and the photographic experimenter were preparing the means which should enable the physicist to decipher the inner structure of the atom, through the ability thus given to photograph the spectral lines.

The gelatino-silver halide emulsion, sensitized or not with certain dyes, has remained the fundamental of the modern photographic process. Its practical utility, however, and its adaption to the needs of cinematography were enormously increased with the replacement of glass by a flexible

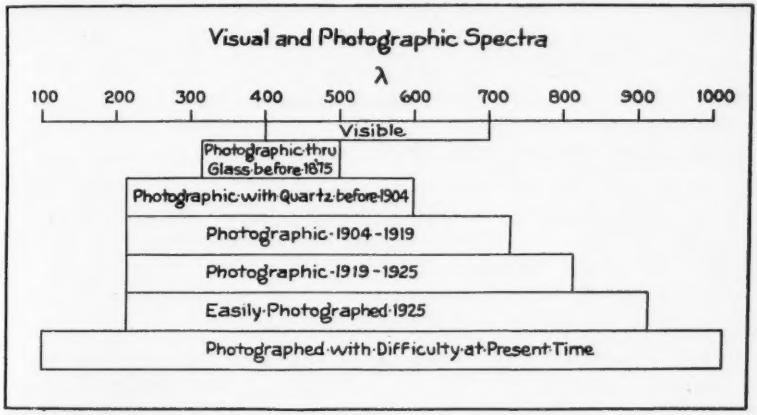


FIGURE 1

support by George Eastman, first in the form of a stripping film and later by the introduction of the celluloid film.

The comparative chronology in the chart indicates roughly but compactly the origins and trend of photographic evolution up to the appearance of the gelatino-silver-bromide emulsion. The big developments since have been in the direction of exploiting the possibilities thereof. In subsequent articles we shall consider in more detail the chemical foundations of the unique position occupied by a mechanical combination of silver halide, gelatin, and a cellulose derivative.

CHRONOLOGICAL CHART: THE DEVELOPMENT OF PHOTOGRAPHY

Date	Optics	Photochemistry
1558	*Camera obscura* described by da Vinci	
1568	and Baptista Porta. Use of lens by Barbaro.	

[8] Taken from "Fifty Years of Photography," by C. E. K. Mees, *Ind. Eng. Chem.*, 18, 915 (1926).

CHRONOLOGICAL CHART (*Continued*)

Date	Optics	Photochemistry
1727		J. J. Schulze discovered light action on silver salts.
1777		Scheele discovered photochemical decomposition of silver chloride. Studied spectrum.
1801		Ritter discovered chemical action of ultra-violet.

	Photography	Daguerreotype	Photoengraving
1802	T. Wedgwood's attempt to fix camera images with silver nitrate.		
1826			Niépce' heliography with asphalt.
1839	H. Fox Talbot made negative prints on silver chloride paper.	Daguerre developed latent image on silver iodide with Hg vapor. Draper made first Daguerreotype portrait.	
1841	H. Herschel used "hypo." Talbot developed latent image on silver chloride paper. Printed positives.	Fizeau "gilded" the image by gold toning. Goddard sensitized with bromine vapor.	
1848	Niépce de St. Victor used albumen on glass. Scott Archer devised wet collodion.		
1852		Daguerreotype extinct.	Talbot found bichromated gelatin sensitivity and applied to photoengraving on steel and copper.
1860	Dry collodion.		Used iron chloride to etch.
1864	Sayce and Bolton invented collodion emulsion.		Poitevin, and Pretsch invented photo-galvanography.
1865	Russell discovered alkaline development.		J. W. Swan devised transfer process.
1871	R. L. Maddox made gelatin emulsion.		"To Talbot is due the great achievement of inventing the bichromated glue process of heliogravure for intaglio printing not only for steel but for copper." (J. M. Eder, "History of Photography," W. Knapp Halle, 1905, p. 391.)
1873	Kennett made gelatin dry plates.		
1873	H. Vogel discovered optical sensitizing by dyes.		
1876	Stuart-Wortley and Bennett ripened emulsions by heat.		
1878			

HISTORY OF THE CHLORINE INDUSTRY

Robert T. Baldwin, Secretary, The Chlorine Institute, Inc., New York City

It is reasonable to suppose that chlorine gas was known to the alchemists, because their one solvent for gold, aqua regia, gave off on heating the fumes of chlorine. The discovery of chlorine, however, is attributed to the Swedish chemist, C. W. Scheele, in 1774. He discovered that on heating black oxide of manganese with hydrochloric acid he obtained fumes similar to those evolved when aqua regia is heated. Scheele called this gas dephlogisticated muriatic acid, on the basis of the then prevailing theory that the manganese had displaced phlogiston, as hydrogen was then called, from the hydrochloric acid. Scheele noticed that the gas was soluble in water, that it gave a permanent bleaching effect on paper and vegetables and flowers, and had action on metals and oxides of metals.

In 1785 Berthollet prepared a bleaching agent by dissolving Scheele's gas in water. In 1789 he improved this bleaching fluid by adding the gas to a solution of caustic potash at a French chemical plant on the Quai de Javelle, Paris, and this solution became known as *Eau de Javelle.* James Watt, inventor of the steam engine, and a chemist of standing, obtained the process of manufacture of *Eau de Javelle* from Berthollet and brought it to Scotland for Charles Tennant, founder of the great English chemical company of that name. Tennant in 1798 made still another bleaching agent, a chlorinated milk of lime, and in 1799 improved upon this substance by making a chlorinated hydrate of lime, a dry product, and known to commerce ever since as bleaching powder. It is also called "bleach" and "chloride of lime."

In the period 1774 to 1810, the nature of Scheele's gas was being investigated by such men as Berthollet, Lavoisier, Gay-Lussac, Berzelius, Thenard, and H. Davy. On July 12, 1810, H. Davy, before the Royal Society, London, said that the gas is an elementary body which, in muriatic acid, is combined with hydrogen. He proposed the name "chlorine" from the Greek "chloros" variously translated "green," "greenish," "greenish yellow," and "yellowish green" in allusion to the color of the gas. Davy's conclusions were generally accepted, although Berzelius did not adopt them for some years afterward.

In 1785, B. Pelletier and, 1786, Karsten had succeeded in obtaining yellow crystals of chlorine hydrate by cooling Scheele's gas in the presence of moisture, and inferred that Scheele's gas was not a simple substance. In 1805 Thomas Northmore liquefied chlorine gas. He called chlorine gas "oxygenated muriatic acid," having adopted the name given it by Berthollet who was convinced at this time that chlorine was a mixture of hydrochloric acid and oxygen. Northmore in describing the experiment says: "Upon the compression of oxigenated (oxygenated) muriatic acid gas in

a receiver two and a quarter inches capacity, it speedily became converted into a yellow fluid of such extreme volatility under the common pressure of the atmosphere that it instantly evaporates upon opening the screw of the receiver. I need not add that this fluid, so highly concentrated, is of a most insupportable pungency. When atmospheric air was pumped into the empty receiver it was speedily filled with dense white fumes. There was a trifling residue of a yellowish substance left after the evaporation, which probably arose from a small portion of the oil and grease used in the machine mixed with some of the concentrated gas;

Reproduced from "Liquid Chlorine," Electro Bleaching Gas Co.

Liquid Chlorine Being Poured into an Open Bucket. Note the frost on the bottom of the bucket, due to the evaporation of the liquid.

it yielded to sulphuric ether, and destroyed vegetable colours. This gas is very injurious to the machine, and on that account difficult to work."

In 1810 Davy proved that the yellow crystals of Pelletier and of Karsten could not be formed at $-40°$ Fahrenheit if dry chlorine gas was used. On March 5, 1823, Faraday, while working with chlorine hydrate in a sealed tube, was visited by Dr. J. A. Paris. The latter noticed some oily matter in the tube, and twitted Faraday for using dirty apparatus. Faraday thereupon started to open the tube, and it shattered, and the oily matter vanished. Faraday studied the accident and Dr. Paris on the following morning received a note—"Dear Sir: The oil you noticed yester-

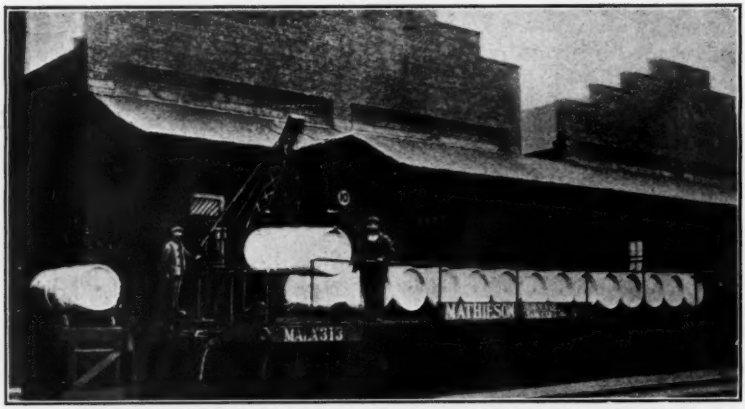
day turned out to be liquid chlorine. Yours faithfully, Michael Faraday." Liquid chlorine remained, from 1805 onward, a laboratory curiosity, and a dangerous one, in glass apparatus, until it was produced on a commercial scale by cooling and pressure and in suitable apparatus, by Knietsch in 1888.

The manufacture of bleaching powder, begun in 1799, grew rapidly, and until about 1836 the chlorine was obtained by Berthollet's method of heating sodium chloride, manganese, and sulfuric acid in lead stills. In 1836, Gossage invented his coke towers for the absorption of waste hydrochloric acid evolved in the LeBlanc soda process. With this cheap acid available, Scheele's method of obtaining chlorine by treating manganese dioxide with hydrochloric acid became largely the commercial method. In 1868 Deacon and Hurter patented the "Deacon" process of preparing chlorine by decomposing hydrochloric acid with oxygen. Again Scheele's method was largely abandoned and the "Deacon" process prevailed until the introduction of the electrolytic method of preparing chlorine in 1890 by the Elektron Co., Griesheim.

In 1833, after years of experimentation, Faraday discovered and formulated the laws that govern the action of an electrical current in aqueous salt solutions. In 1851, Charles Watt obtained an English patent for the electrolytic manufactures, including chlorine, caustic soda, and sodium hypochlorite, but as there was no practicable dynamo for electric current available the patent was largely of academic interest. With the introduction of better dynamos in the seventies and the eighties, interest in electrochemistry was greatly stimulated, and as before stated, the commercial production of electrolytic chlorine was attained in Germany in 1890. The first American commercial production was at Rumford Falls, Maine, in 1893. The English began the electrolytic manufacture about the same time and within a decade there were numerous small electrolytic plants in Germany, England, and the United States of America. The first Canadian plant was established in 1912.

In Germany non-electrolytic chlorine had been liquefied on a commercial scale in 1888, as said before, and electrolytic chlorine was first liquefied on a commercial scale in America in 1909, and in England about 1912. From 1799 until 1888, bleaching powder was, excepting for small quantities of chlorine-containing solutions, such as *Eau de Javelle*, almost entirely used as the substance yielding chlorine for bleaching and other purposes. The English, and later the Germans, built up large export businesses in bleaching powder, and consumed great quantities in their home markets, especially in England where the bleaching of cotton textiles had been well established long before the advent of chemical bleaches. America, from about 1870 to 1893, was a very large consumer of English bleach. When the American plants got under way, the imports declined rapidly and have

since all but disappeared. Small shipments of liquid chlorine were exported from Germany to the United States of America from 1888 onward, but the business did not grow because shipments were restricted to cargo boats and were carried as deck loads and were subject to instant jettison in the event of cylinder leaks. Furthermore, there was a heavy American duty on the steel cylinders, and endless customs red tape in securing ear marking or drawback of duty. Industries requiring chlorine were using bleaching powder, and loath to try a new substance which might not always arrive in time for their needs. In Germany the dye and related synthetic organic chemical manufactures stimulated the use of liquid chlorine, thus replacing bleaching powder. As the English and Americans had no synthetic organic chemical industries of importance until after the



Reproduced from "Mathieson Hypochlorite Process," The Mathieson Alkali Works, Inc.

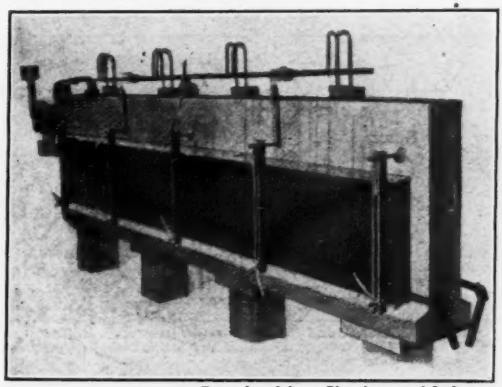
Shipping Liquid Chlorine in Large Quantities. Multiple-Unit Tank Car.

war started in 1914, liquid chlorine came but slowly into commercial importance in America and England. The first commercial American liquid chlorine manufactured was in 1909 and the chlorine was furnished in steel cylinders, of German manufacture, containing one hundred pounds. In this same year was started anew the work of interesting the users of bleaching powder in liquid chlorine. This business grew slowly but steadily, largely through the pioneer efforts of E. D. Kingsley who spared no effort to interest, first, the bleachers of cotton textiles and, a little later, municipal water works which had already, in a few cases, begun to treat potable water supplies with bleaching powder as a sterilizing agent.

In 1909 the first American fifteen-ton tank car for railroad transportation of liquid chlorine was put into service, the chlorine being used in the detinning of scrap tin. Cylinders containing one hundred and fifty

pounds came into use, and, in 1917, the United States Army Chemical Warfare Service used a one-ton container. Still later, a car holding fifteen of the one-ton tanks was put into service. In the American industry at this time over three hundred tank cars of both types and eighty thousand cylinders are in use. The transportation of liquid chlorine is regulated by law in Europe, England, Canada, and the United States of America. The regulations are elaborate, and are rigorously enforced, and great quantities of liquid chlorine are transported and handled yearly with almost complete absence of accident.

The use of bleaching powder has declined rapidly of late years in Germany, Canada, and the United States of America, and to a lesser extent in England. Liquid chlorine, properly packaged and stored in a cool spot, will keep indefinitely. The pressure on the cylinder walls is well within



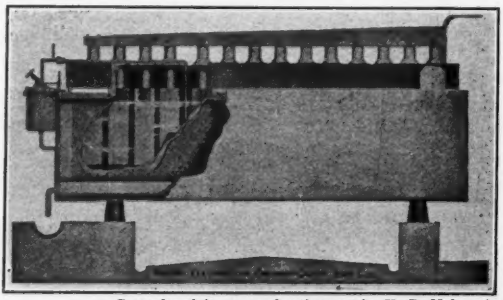
Reproduced from Chemistry and Industry

Allen-Moore Cell.

the safety limits at all ordinary temperatures, and liquid chlorine has no appreciable action on the steel of the container. On the other hand, bleaching powder and its packages, either wood or sheet iron, deteriorate quite rapidly. A remarkable technic in the application of gaseous or liquid chlorine, on release from the containers, has been built up by degrees. This gradual shift from bleaching powder, containing when fresh about thirty-five per cent available chlorine, to liquid chlorine, practically one hundred per cent chlorine, illustrates well the modern tendency in chemical industries to use elemental or simple substances in concentrated form.

In the rise of the practical electrolytic cell for chlorine from 1890 onward there have been many developments and great expenditures of time and money. The cell is still a far from perfect thing and requires skilled

attention. Three substances, chlorine, a noxious gas, hydrogen, a flammable gas, and caustic soda, a powerful alkali, are produced simultaneously. For economic reasons a chlorine plant is operated seven days weekly with three eight-hour shifts. In the earlier days of the industry abroad, it was thought that the electrolytic chlorine process would supplant the Solvay soda process, just as the latter had supplanted the LeBlanc soda process. That is to say, it was felt that caustic soda was now to be made in a comparatively simple operation as compared with the older processes, and that caustic soda could somewhat replace soda ash and that the introduction of carbon dioxide at the cathode cell compartment would produce cheap soda ash. These ideas, workable as they are, presupposed sufficient uses to balance the chlorine production. These chlorine uses did not exist then and do not exist now. Approximately, the commercial manufacture of one ton of electrolytic chlorine entails the manufacture of a little more



Reproduced from an advertisement by H. R. Nelson in Chemical and Metallurgical Engineering

Nelson Cell.

than a ton of caustic soda and about nine thousand cubic feet of hydrogen. The economic existence of the chlorine cell depends on the profitable utilization of this chlorine, with the caustic soda and the hydrogen as by-products. Chlorine in quantity cannot be passed into the air or the sewer with impunity. The caustic soda liquors, as they come from the cell, average from eight to twenty-five per cent of caustic soda depending on the type of cell. These liquors are concentrated in evaporators and pans to fused caustic soda, or with some evaporation to fairly strong solutions. These solutions are shipped in tank cars, but are obviously restricted to short hauls because of heavy freights on a low caustic soda content. In either case this caustic soda must compete with that made by causticizing ammonia soda process soda ash with lime. The hydrogen is very pure, and in the United States of America is now largely coupled with nitrogen in the synthesis of ammonia. It is also employed in the hydrogenation of oils, and in the synthesis of hydrochloric acid.

The productive capacity of the chlorine industry both in the United States of America and elsewhere had overtaken the demand before the World War. The war needs added to the capacity and since 1918 in England, France, Germany, Italy, and the United States of America the available capacity has far outstripped consumption. This has led to renewed searches for more uses. The noxious character of chlorine gas, its corrosive action in the presence of moisture, its readiness to attack nearly all known substances, and to unite with nearly all gases but the rarer ones, render its manufacture, handling, and use a very technical matter. Nevertheless, its manufacture, handling, and use in the industrial arts have been remarkably free from serious accidents.

Chlorine is indispensable today, and the measure of its use is an index of the comparative civilization of a country.

BIBLIOGRAPHY

"The Early History of Chlorine," *Alembic Club Reprint* No. **13,** Edinburgh, 1902.

Mellor, "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," Longmans, Green and Co., New York, **1922.**

Ludwig Mond, "History of the Manufacture of Chlorine," *J. Soc. Chem. Ind.*, **15,** 713–719 (1896).

Thomas Northmore, "Experiments on Condensed Gases," *Nicolson's Journal (Journal of Natural Philosophy, Chemistry and the Arts)*, **13,** 234–235 (1806).

D. A. Pritchard, "Economics of Chlorine," *Trans. Am. Electrochem. Soc.*, **1926.**

Metal Shrinks When Magnetized. Changes in monel metal, a widely used alloy of nickel, copper, iron, and other metals, as it is magnetized, are just in the opposite direction from similar changes in iron, Prof. S. R. Williams, of Amherst College, told members of the American Physical Society at their recent meeting.

"If a rod or bar of magnetic material such as iron or steel is magnetized in its long direction," said Prof. Williams, "it will change its length as the magnetizing force is increased from zero upward. This is known as the Joule magnetostrictive effect." Iron, he explained, first increases in length as it is magnetized until a certain degree of magnetism has been attained, and then shortens. Nickel shortens for all degrees of magnetization, while manganese lengthens for all.

However, the speaker continued, the change in monel metal is just the opposite of that in iron. First, a bar of the material shortens as it is magnetized, and then it lengthens. It also changes in length while a constant magnetic force is applied. This is done by means of a solenoid, or coil of wire, around the metal rod, through which an electric current is passed. The shortening has only been studied, however, over a period of application of the magnetizing force for about two minutes, for by that time the solenoid begins to get heated by the current flowing through it. This in turn heats the rod, and causes it to expand.

"It is an interesting effect," said Dr. Williams, "to watch this contest between the shortening due to the magnetic field and the lengthening due to the heat effect. The spot of light which records the changes in length of the metal bar swings up and down like the breathing of some living organism."—*Science Service*

THE LIFE OF EDME MARIOTTE*

LUDWIG DARMSTAEDTER, PREUSSISCHE STAATSBIBLIOTHEK, BERLIN, GERMANY

We owe the great men of science not only a careful reading of their works but also a study of their lives and characters so that they may appear to us as real personalities. We can then better understand how they came to undertake and accomplish their tasks and appreciate in what way their achievements reacted in determining the course of their careers. Practically nothing is known about the lives of many of our intellectual giants and we are forced to construct our notions of the motives which influenced their careers from a consideration of their writings.

This is especially true of Edme Mariotte. The existing records contain so little concerning his life, that even the year and place of his birth are uncertain. The mathematician, Marie Jean de Condorcet, in his "Eulogies of the Academicians 1666–1699," considered Mariotte's accomplishments worthy of praise, but he knew nothing to record concerning the circumstances of his life, although only one hundred years had elapsed since his death. Today, after the passage of three hundred years, we are perforce compelled to judge him from his writings alone.

The most important of his works known to us deals with the Law of Mariotte, which is better designated as the Boyle-Mariotte Law, since Robert Boyle took an active part in its establishment. This law states that the volume of a given mass of gas varies inversely with the pressure impressed on it. In the paper entitled "Sur la nature de l'air," read in 1676 and included in "Histoire de l'Academie," page 176 (published 1733), Mariotte says, "Air expands and contracts according to the weight resting on it," and he illustrated this statement by a simple experiment. "I took a tube 40 inches long and poured into it $27\frac{1}{2}$ inches of mercury, so that $12\frac{1}{2}$ inches of air were in the tube. I now inverted the tube and plunged it one inch deep into mercury. The column of mercury fell and came to rest at a height of 14 inches, that is, at one-half the height of the ordinary air pressure of 28 inches. The enclosed air occupied the upper part of the tube, amounting to 25 inches; its volume doubled since it originally had occupied only $12\frac{1}{2}$ inches.

Boyle had previously discovered this relation between volume and pressure in 1660 and had demonstrated it by a simple experiment. "He enclosed 12 cubic inches of air in the shorter arm of a bent tube by means of a mercury seal. He then poured mercury into the longer arm and the enclosed air was compressed in the same measure as the mercury was added. With double the original quantity of mercury, the volume of the air was 6 cubic inches; with triple the quantity of mercury, the volume

* Translated at the author's request by Ralph E. Oesper, University of Cincinnati, Cincinnati, Ohio.

was 4 cubic inches; or the air was compressed in direct ratio to the compressing force."

Mariotte was also perfectly clear in his ideas about air pressure and its dependence on the height above the surface of the earth. The famous experiment carried out by Pascal's brother-in-law, Perier, on the Puys de Dome in 1648, had only shown that the air pressure varies with altitude. Mariotte pointed out that the fall of the mercury column might be used as a measure of altitude and recommended that the barometer be used for this purpose. He stated that an ascent of 60 feet caused the mercury to fall about one division on his scale.

Edme Mariotte is thought to have been born in Dijon about 1620 and was destined for the clergy in his early youth. Nothing is known about his education, but he seems to have risen to eminence quite early for he was prior of the monastery of St. Martin sous Beaune near Dijon when the Academie des Sciences was founded by Colbert in 1666. It appears from the "Histoire de l'Acadamie Royale des Sciences" that he was unusually active as a member and, up to the middle of 1683, he seldom missed a meeting and was interested in the most diverse subjects presented to that body. This activity indicates that his position as prior was merely a benefice, and Mariotte seemed to have spent most of his time in Paris pursuing his scientific studies.

One of his earliest investigations, that on the eye, was presented before the Academy in 1669. He found that the entrance of the optic nerve, the pupilla optica, or the blind spot, was not exactly in the center line of the eye, but was situated somewhat higher and closer to the nose. Simple experiments showed him that a round piece of paper fixed to another whose image fell on the blind spot, disappeared when both were observed with only one eye. In the antero-posterior axis of the eye, he observed a thinner portion colored yellow and hence known as the yellow spot, and he regarded this as the light sensitive region. This discovery, although much doubted, later was proved to be correct. The blind spot is often known as Mariotte's spot.

In 1674 Mariotte developed the laws of percussion and the type of apparatus which he devised for detecting shocks is still used.

His treatise on the nature of colors, presented before the Academy in 1679, is of great interest and in the history of that organization, it is stated: "Such studies were particularly suited to Mariotte because he was unusually keen in his observations and he performed experiments just as expertly as he devised them." In this paper he offered an explanation of the halos and rings seen around the sun and moon in misty weather, and said that the greater halos were produced by double refraction and simple reflection in the ice crystals of the upper layers of the earth's atmosphere. This explanation is still accepted. He also included a note

on radiant heat to which Melloni referred later. Mariotte observed that the sun's rays passed through transparent bodies without noticeable weakening, while most of the rays from a fire, although not so hot, are reflected.

Condorcet said of him, "Few investigators have shown, in their writings, a more upright and disinterested love of the truth than did Mariotte." This was true of all the instances cited above and also applies to his studies of hydrostatics and hydraulics, presented in 1669 before the Academy, and published in 1717, after Mariotte's death, by Philippe de la Hire, to whom they were entrusted in the first days of Mariotte's last illness. Moritz Rühlmann, in his text on technical mechanics, regards them as the first worthwhile measurements of the velocity of water flowing in rivers, canals, and from emptying vessels, of the movement of water in pipes, of jets of water, and the impact of moving water. In addition, while calculating the strength of the walls of pipes, he treated the bursting strength of prismatic bodies more correctly than had Galileo before him.

Mariotte died May 12, 1684, in Paris. In that year he had clearly demonstrated, by experiments and statistics, the meteorological source of water issuing from springs, and he also devised the Mariotte flask, the purpose of which is to permit the exit of large masses of water without change of pressure.

Bursts of Color to Greet Next Naval Foe. Our next enemy on the sea will be greeted by a color scheme of shell splashes that will knock his eye out!

For naval ordnance experts have designed a shell for large naval guns which will color to any desired hue the great geyser that it throws up on striking the water.

A small tube containing a secretly prepared, quick-spreading dye together with a detonator or fuse is ingeniously fitted inside the nose of the shell. On striking the water, the sensitive fuse explodes a bursting charge sufficient to scatter the dye over a comparatively large area. The boiling mass of water thrown up by the impact of the shell carries the quick-spreading dye with it, thoroughly coloring the whole mass. Since the long pointed nose or windshield attached to the shell has nothing to do with its armor-piercing ability, the attachment of this ingenious device does not affect its efficiency.

Heretofore, when two or more ships fired at a common enemy, it was next to impossible to identify the splash of their own salvos at battle ranges of fifteen to twenty miles, and the observers were thus at a loss as to the amount to raise or lower their sights in order to bring the shots on the target.

By use of the color-making device, this greatest of all gunnery problems will be eliminated. By the use of different colors for different ships, each may with ease distinguish the splashes of its own salvos. Ships having the same colors, as might happen in a fleet action, would be so widely separated in the battle line as to avoid any chance of confusion.—*Science Service*

THE VITAMINS. V

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Vitamin E

Evans and Bishop[1] found that rats kept for relatively long times upon mixtures of purified foodstuffs and with ample provision for all previously known vitamin requirements finally showed evidence of needing, for successful reproduction, an hitherto unknown fat-soluble substance which they first called "X" but which is now known as vitamin E, or, descriptively, as the "antisterility" vitamin. This latter term sometimes gives rise to a misapprehension, which is still more likely to arise if the substance is called, "the vitamin of reproduction;" for while vitamin E is undoubtedly essential to reproduction, it is certainly no more so than vitamin A. A diet devoid of vitamin A stops reproduction quite as certainly, and may stop it quite as quickly, as a diet devoid of vitamin E. Hence no one vitamin can properly be called "the" vitamin of reproduction; the phrase "the antisterility vitamin" is also likely to prove misleading since in actual experience nutritional sterility is more likely to be due to a shortage of vitamin A than to a shortage of vitamin E. Vitamin E, therefore, is no more directly or essentially concerned with reproduction than is vitamin A, and in fact vitamin A is probably of the greater practical importance of the two; but its rôle in the prevention of sterility is the only known function of vitamin E, while vitamin A is known to have many other important functions in addition to its essential part in the nutritional processes of reproduction.

A lack of vitamin A causes failure of reproduction through interfering with ovulation, whereas a lack of vitamin E interferes with placental function; and these two disturbances of the reproductive process are clearly distinguished by the histological technic developed and used by Evans and Bishop who, therefore, feel that in their work there is no danger of a shortage of the one being mistaken for a shortage of the other. In later papers Evans has reported that diet devoid of vitamin E leads eventually to destruction of the germ cells in the male, whereas in the female the ovary and ovulation are not impaired but the failure of placental function with death and resorption of the foetus is highly characteristic. He emphasizes the view that it is only by ascertaining the existence of typical "resorption gestations" that one may assume that he is dealing with a deficiency of vitamin E.

The effects of a deficiency of vitamin E in the food may be relatively slow in appearing, one or more litters often being borne and reared by the

[1] H. M. Evans and K. S. Bishop, *Science*, **56**, 650 (1922); *J. Am. Med. Assoc.*, **81**, 889 (1923); *J. Metabolic Research*, **1**, 319, 335 (1922); **3**, 201, 233 (1923).

animals originally subjected to the vitamin E-free food and, sometimes, even by their offspring also when continued on the same deficient diet. This may be explained on the ground of storage of vitamin E in the body and the transmission of a part of the mother's store to her offspring either during pregnancy or lactation, or both. Failure on the part of others to realize that the body may carry a sufficient store of vitamin E to meet its needs for a relatively long time and even to share with the offspring so that the latter may also start with a reserve store, is doubtless one of the reasons that some other investigators have hesitated to concur with Evans as regards the existence and importance of vitamin E; but to the writer there seems no room for doubt in view of the further evidence published by Evans and Burr.[2] They record the results of a continuation and extension of the reproduction work begun by Evans and Bishop, and also of studies of the distribution of vitamin E in tissues and foods, and an experimental investigation of the concentration and properties of the substance summarized in a diagram too extensive for reprinting here.

Seeds and green leaves were found to furnish vitamin E in abundance. The fat of the wheat germ was especially rich in the vitamin and it is thought that most vegetable oils may contain more or less of it. It does not seem to be destroyed by the refining and hardening processes to which commercial fats and oils are subjected. It was found to be present, though not in high concentration, in a variety of animal tissues including muscle, fat, viscera, and milk. In one series of experiments, 9 per cent of butterfat, together with 15 per cent of lard, failed to provide enough vitamin E; but 24 per cent of butterfat made the diet adequate. Whole milk powder as the sole food was also found to furnish adequate amounts of vitamin E, and there was definite evidence of a higher vitamin E content in the milk of cows on fresh alfalfa pasturage. From the latter observation it would follow that butter must also be expected to show variation in its vitamin E content. Failure to take due account of this probability may explain the failure of some other investigators to confirm certain of Evans' results.

In the paper above cited, Evans and Burr summarize their findings in part as follows:

> Vitamin E is remarkably stable to heat, light, air, and many of the ordinary chemical reactions.... Distillation of wheat germ oil, or a fraction out of it, in superheated steam at 180°C. for several hours has not destroyed it. Distillation *in vacuo* up to 233°C. has not in fact caused any lowering of the potency of the fractions so treated nor have any physical changes like changes in solubility been detected. We have not encountered evidence that daylight affects E in wheat germ oil, but there would appear to be partial destruction by one hour exposure in thin layers to a powerful quartz mer-

[2] H. M. Evans and G. O. Burr, *Proc. Nat. Acad. Sci.*, **11**, 334 (1925).

cury lamp. As regards oxidation, exposure of wheat germ oil for as many as twelve hours to a stream of air washed with acid and alkali and at 97°C. has not destroyed E. At normal temperatures the vitamin is remarkably stable to both acid and alkali and many chemical treatments. It dissolves unchanged, for instance, in saturated alcoholic hydrogen chloride. We have hydrogenated wheat germ oil in the presence of palladium at 75°C. and no injury to the vitamin resulted....It resists the action of boiling 20 per cent alcoholic potassium hydroxide though partial destruction would appear to occur on very prolonged hot saponification. The saponification with 20 per cent alcoholic potassium hydroxide can be carried out at 30°C. without great loss of the vitamin which goes into the non-saponifiable quota, five per cent of the oil, so that by this step alone a notable concentration of E is always attained. The non-saponifiable quota is in turn chiefly (73 per cent) sitosterol, which is largely insoluble in pentane in the cold, an excellent solvent for vitamin E, which together with pigments and other materials can thus be washed out of the sterols, leaving them white. The sterols are inactive. The orange-red viscous oil obtained from the pentane can be treated with methyl alcohol, removing more extraneous material, the vitamin going in the alcohol portions which now can be mixed with petroleum ether and diluted to 90 per cent methyl alcohol, allowing an immediate separation into two layers, the petroleum ether invariably securing more of the vitamin, in fact all of it, if the distribution be done with successive fresh portions of the petroleum ether. Further purifications can now be carried out both with digitonin, boiling methyl alcohol, and finally distillations *in vacuo*.

The final yellow viscous oil does not develop crystals on long standing. It contains only a trace of ash and no nitrogen, sulfur, phosphorus, or halogen. It is remarkably potent. When five milligrams are fed or injected under the skin of a female of proven sterility at the inception of a new gestation, normal litters of vigorous young are born and have been reared to adulthood. Sister control rats invariably continue sterile. Furthermore, the daily administration of only three-tenths of a milligram of this substance throughout the life of the male (rat) results in the retention of complete normality when animals are reared and held on pure foods.

In this account of vitamin E we have drawn chiefly upon the work of Evans and associates, of the Department of Anatomy, University of California, who discovered this vitamin and have been most active in the investigation of it. Limitations of space permit of but brief reference to the work of other investigators who have contributed to our knowledge of this substance.

Mattill, Carman, and Clayton[3] reported in 1924 that a type of male sterility previously attributed to lack of vitamin B appeared rather to be due to lack of vitamin E (called "the X substance" in their paper); and that this dietary deficiency if sufficiently prolonged induces sterility in both sexes, which is more likely to be permanent in the case of the male than of the female. This aspect of the subject is discussed further by Mattill in a very recent paper.[4]

Sure in a series of papers[5] has confirmed Evans' work at various points

[3] H. A. Mattill, J. S. Carman, and M. M. Clayton, *J. Biol. Chem.*, **61**, 729 (1924).

[4] H. A. Mattill, *Am. J. Physiol.*, **79**, 305 (1927).

[5] B. Sure, *J. Biol. Chem.*, **58**, 693 (1924); **62**, 371 (1924); **63**, 211 (1925); **69**, 29, 41, 53 (1926).

and contributed further observations on the occurrence and solubilities of vitamin E, and the problem of its relation to lactation or to a lactation-promoting factor.

Nelson[6] has called attention to a number of points on which care must be exercised in generalizing from the details of Evans' experiments. Doubtless some writers have been too hasty in attributing to shortage of vitamin E, various failures of their experimental animals to reproduce successfully, when in reality other causes may have been responsible. But there seems now an overwhelming preponderance of evidence in favor of the view of the existence of this fifth vitamin; and it is an interesting illustration of the unity of science that this chemical substance of great physiological importance was discovered as the result of the embryological researches of a professor of anatomy.

[6] V. E. Nelson, V. G. Heller, and E. I. Fulmer, *J. Biol. Chem.*, **57**, 415 (1923).

High Power Arc Gives Mutilated Atoms. Electric arcs, using a current of a thousand to two thousand amperes, more than ten times as much as the arcs in the projectors of large movie theaters, have been used to obtain the spectra of atoms from which one or more of their electrons have been lost, according to Dr. Arthur S. King, who presented a paper at the meeting of the American Physical Society. Dr. King is in charge of the physical laboratory of the Mt. Wilson Observatory in Pasadena, Calif., where he performed his experiments.

By means of these arcs, obtained by passing the high current between small metallic rods in a vacuum, extremely high temperatures are obtained so that the electrons in the atoms are made to jump from one path to another. Such electron jumps, according to modern physical ideas, occur whenever energy, whether light or heat, is given off from a substance; but in the high power arc, jumps occur that are ordinarily rare because so much energy is obtained to displace the electron. Sometimes, in the arc, the electrons leave the atom completely and the spectrum, obtained when the light is passed through the prism of a spectroscope, reveals these changes.

Previously it was not possible to obtain these characteristic spectrum lines in great intensity, but now they are obtained on a large scale. These experiments may help astronomers to understand better peculiar effects in star spectra.—*Science Service*

Scientists Strive to Purify Helpful Hormone. Working with apparatus under a pressure of five atmospheres two scientists at the University of Denver are endeavoring to isolate the female sex hormone and obtain it free from harmful impurities.

Dr. R. G. Gustavson and Hugo Krueger, reported to the American Association for the Advancement of Science that they had succeeded in dissolving the valuable substance in liquid ammonia. Since ammonia can only be liquefied at a point far below the freezing point of water, the experimental difficulties the workers have had to overcome are obvious. Their achievement is important because it separates the hormone from cholesterol, one of its common impurities, which is not soluble in ammonia.

It is believed that the administration of the female sex hormone will be of great benefit if it can be obtained in a state free from the impurities that might cause harm when injected into the human system. In consequence its isolation in a chemically pure state has been the goal of many chemists and physiologists.—*Science Service*

THE REALITY OF THE ATOM*

WHEELER P. DAVEY, RESEARCH STAFF, GENERAL ELECTRIC CO., SCHENECTADY, N. Y.[1]

All chemical theory found in our text-books is based on the assumption that the material universe is made up of a limited number of elementary substances called "elements" and that these "elements" are composed of minute particles called "atoms," each of which tends to retain its identity under all ordinary conditions of temperature and pressure even when brought into intimate contact with "atoms" of some other "element." The effects of this assumption are very far reaching, for most of the chemical processes so essential to our modern civilization have been worked out on the basis that the assumption is true and that these atoms are real and have an actual existence. But no one has ever seen an atom, and if our currently accepted laws of the resolving power of lenses are at all true, it may be predicted that no one will ever be able to see an atom. All evidence as to the existence of atoms must, therefore, be indirect, and the scientist is compelled to play the part of a detective.

In a criminal case, a detective starts out with certain known facts. From these facts he tries to reconstruct a picture of the crime. If his picture is correct he will be led to the discovery of new facts which are consistent with his picture. If, however, facts are found which are inconsistent with his picture of the crime, he must either alter the picture to account for the new facts or he must build himself an entirely new picture. For instance it may be shown that Mr. X.'s revolver was found near the scene of the crime, that his shoe fits the footmarks, that he was known to have hated the victim, etc. But when the detective interprets all this as showing that Mr. X. committed the crime, he may or may not be correct. Further investigation may show that Mr. X. was playing checkers two miles away at the time the shot was fired. In such a case, the facts as to the revolver, the footmarks, etc., are still facts, but a new interpretation must be found for them. It should always be possible to construct an infinite number of theories each of which will correlate, or "explain" any given finite number of facts. We have all read of instances where a man has been convicted on the basis of very strong circumstantial evidence, only to be proved innocent after many years. The chance of error in a picture founded solely on circumstantial evidence is so great that our courts usually require the testimony of eye witnesses or a confession of guilt before they will convict a man of murder.

All research scientists are detectives, and our evidence is necessarily circumstantial evidence. It is for this reason that scientists are often

* First lecture, Howe conference, Williamstown Institute of Politics, Williamstown, Mass., Aug. 4, 1926.

[1] Present address: School of Chemistry and Physics, The Pennsylvania State College, State College, Pa.

accused of "not believing anything." A true scientist must always keep before himself the possibility of some other interpretation of the facts revealed by his experiments. It is for this reason that when non-scientific men say "I know" the scientist says "I assume." When the average man says "It is ——" he means to imply "It actually is ——." Scientists long ago tacitly agreed that when they discussed matters of theory among themselves, the statement "It is ——" was to be taken as an abbreviation for "It acts as though it were ——." So a scientist would interpret the topic of our discussion to mean, not "Do atoms really exist?" but rather "Does matter always act *as though* it were really made up of atoms?" It is with the answer to this question that we must deal here.

After a consideration of the facts available at the time (about 1725) Isaac Newton gave what is probably the first definite statement of the atomic theory.

> "It seems probable to me, that God in the beginning formed matter in solid, massy, hard, impenetrable, moveable particles; of such sizes and figures, and with such other properties, and in such proportions to space, as most conduced for the end for which he formed them; and that these primitive particles, being solids, are incomparably harder than any porous bodies compounded by them; even so very hard, as never to wear or break in pieces; no ordinary power being able to divide what God himself made One, in the first creation." (*Optics*, Book III; Works, 1782, IV, 260.) Said by Lowry not to have been included in the first edition of the *Optics*, published in 1704.

This idea was extended in 1808 by Dalton who assumed that elementary substances were made up of "simple atoms" and that compounds were composed of "compound atoms" which later became known as "molecules." Not only was such a picture consistent with all the chemical facts known at the time, but it continued to be so consistent with the accumulated data of the following hundred years that only one essential change had to be made in it. The electrical and osmotic properties of certain solutions led chemists and physicists to assume that water (and to a lesser extent some other solvents) could separate the molecules of acids, bases, and salts into two or more electrically charged components called "ions." A solution of NaCl in water was, therefore, pictured as containing Na^+ and Cl^- in addition to molecules of NaCl. Dalton's simple picture of atoms and molecules was still retained, except that in aqueous solutions it was slightly complicated by the presence of "ions."

Except for this one change, every new fact in chemistry and physics, and every new calculation in kinetic theory seemed only to add to the evidence in favor of the existence, in every compound, of molecules each made up of hard, elastic, impenetrable, spherical atoms. At the beginning

of the present century no theoretical structure seemed to stand on a more secure foundation. The mass of circumstantial evidence was so great and so consistent that if it had been evidence in a murder trial the defendent would undoubtedly have been hanged in spite of the absence of eye witnesses. Yet such a simple picture of the nature of matter will no longer serve to correlate the known facts. The results of the last quarter of a century of research in radio-activity, spectroscopy, and crystal structure have made necessary great changes in our ideas of the constitution of matter. The early simple picture of hard solid atoms which had been supported by so much circumstantial evidence has had to be drastically altered, and the picture of the ion has grown in importance at the expense of the atom and the molecule.

It would be beyond the scope of this discussion to give a detailed account of the present picture of the inner structure of atoms. It will be sufficient to say that the known facts are consistent with the picture that atoms have a central nucleus which carries a positive electric charge and that this nucleus is surrounded by elementary particles of negative electricity called "electrons." According to the modern picture an atom would not look like a solid baseball. If the positive nucleus is represented by a grain of sand, the electrons would be house-flies at various distances from it, the outmost fly being about 1000 feet away. In spite of this each atom must still retain most of the characteristics of a hard baseball. Otherwise solid substances like iron or concrete could be compressed easily, and structural materials as we know them would be impossible. We are, therefore, led to assume that each atom has a region around it, called the "atomic domain" which may not be easily entered by any other atom. The positive nucleus and most (possibly all) of the electrons are supposed to reside in this domain. The shape, size, and rigidity of this domain are pictured as depending upon the nature of the electrostatic field belonging to the nucleus and the electrons.

The study of crystal structure as determined by X-rays has had an important part in helping us to picture the shape and size of the various atomic domains and has contributed largely to our picture of ions and molecules. It is an experimental fact that, under the proper conditions, an X-ray beam is bent by a crystal. Such an effect is consistent with the picture previously held by crystallographers that a crystal consists of an orderly geometrical arrangement of atoms or molecules. It is hard to imagine any other interpretation which will include all the experimental facts. From experimental data which include the amount of bending of the X-ray beam and the relative intensities of the bent beams, it is usually possible to determine not only the arrangement which the atoms must have in a crystal, but also the distance from the center of one atom to the center of the next.

All this tells at once what must be the shape of the atomic domains. For instance, copper is assumed to have spherical atomic domains because the X-ray data lead us to a picture of atoms grouped together exactly like the familiar pyramid of cannon balls, and that packing is one of the two alternative closest packings for spheres. Similarly the atomic domains of all the other malleable and ductile metals like gold, silver, and aluminum are pictured as being spherical, and their high ductility and low tensile strength are exactly what might be expected on the basis of such a picture. The same sort of reasoning leads us to assume that zinc has spheroidal atomic domains, and here again the ductility of zinc in different directions in the crystal is consistent with the picture. Iron below red heat gives X-ray data which make us think of cubic atomic domains touching each other at the corners. Such a structure is inherently less ductile than that described for copper. Above red heat, iron gives markedly different X-ray data from what it does at lower temperatures and these new data correspond to the ductile type of crystals with spherical atomic domains. All this gives a rational explanation of why the blacksmith of our childhood days heated his iron bar above red heat before he hammered it into horseshoes, and helps us to understand one reason why today the blacksmith's successor in the automobile factory drop-forges his crankshafts hot.

Even such a brief sketch of our pictures of the sizes and shapes of atomic domains is sufficient to show how definite these pictures are. X-ray studies of the crystal structures of metals give results which are consistent with the picture that the crystals of metals are built up of individual *atoms*, not of molecules. Theoretical considerations have led Langmuir to assume that this is not true for all the elements. For instance, there is good reason to believe that the unit of nitrogen is a *molecule*, composed of two atoms, and that these two atoms, instead of existing side by side, are coalesced so that the two positive nuclei are adjacent to each other ("twinned") with all the electrons of both atoms held in common about this twinned nucleus. Such a molecule should have the "shape" of a distorted sphere. Similarly, oxygen might be assumed to be made up of nearly spherical molecules of two atoms each. Work, as yet unpublished, by J. O. Wilhelm at the University of Toronto seems to show that solid oxygen actually crystallizes as though it were made up of slightly distorted spheres, each of which has a mass double that of an oxygen atom. It is a pleasure to express my thanks to Mr. Wilhelm for permission to mention his results in advance of publication.

All the recent work of Sir William Bragg and his associates on the crystal structure of organic compounds tends to strengthen the picture that organic compounds are built up of real molecules. Work on the electrical properties of organic compounds makes it seem that the molecules are made up of *ions* not *atoms*.

The old picture of the nature of inorganic chemical compounds was very simple. Quartz was supposed to be made up of molecules each of which had one atom of silicon and two atoms of oxygen and the two oxygen atoms were supposed to be closely adjacent to the silicon atom to which they were combined. All chemical compounds were formerly supposed to have molecules of this sort. Crystals of H_2O, HCl, N_2O, NH_3, CO_2, SiO_2, Al_2O_3, Cr_2O_3, and Fe_2O_3 are still supposed to be built up of real molecules. For instance, a study of quartz by Bragg and his associates and by Wyckoff leads to the picture of an elbow-shaped molecule of SiO_2 with the silicon at the bend in the elbow. Bragg's work on Al_2O_3 leads us to picture the three oxygens as being at the corners of an equilateral triangle with one Al immediately above and one immediately below the center of the triangle. But these molecules are no longer thought of as being made up of *atoms*, but of *ions*. The silicon in SiO_2 is supposed to have given up two electrons to each of its oxygens, so that the SiO_2 molecule is now thought of as being an elbow with Si^{++++} at the bend and O^{--} at each end. Such a picture is very consistent with the optical properties of quartz. Similarly Al_2O_3 is supposed to be made up of $2Al^{+++}$ and $3O^{--}$.

All other crystals of inorganic compounds whose structures have been solved seem to have no molecules whatever. For instance, table salt gives X-ray results which are interpreted by everyone as showing that each Na^+ is surrounded by six Cl^- all equally spaced from it. Similarly each Cl^- is surrounded by six Na^+ all equally spaced from it. Such a structure makes it almost impossible to speak of a crystal of NaCl as though it were built up of molecules each composed of one atom of Na and one atom of Cl.

The shapes and sizes of the ionic domains of the alkalies and the halogens have been thoroughly studied, with the result that the Na^+ ion is considered to be considerably smaller than the Cl^- ion. Now suppose that such a crystal is heated. The inter-ionic spacings should become greater. At some temperature below the melting point it should be possible to pull the Na^+ toward one face of the crystal by an electrostatic field without moving the Cl^-. Joffé reports that he has tried the experiment with successful results. Oxides like CaO, MgO, and ZnO also show an ionic structure. Even $CaCO_3$ is pictured as being made up of Ca^{++} and CO_3^{--}, and Professor W. L. Bragg has been able to calculate the two indices of refraction for two different crystal forms (calcite and aragonite) on this basis. Recent work in the Research Laboratory of the General Electric Company leads to the picture that intermetallic compounds are ionic in their nature. This has since been confirmed by other experimenters.

This hurried and qualitative account of recent work serves to illustrate the increase in complexity of our picture. Some compounds are pictured as being made up of molecules which in turn are made up of ions. Other compounds are pictured as being merely orderly geometrical assemblies

of ions. Only the chemical elements are thought of as being built up of electrically neutral atoms, and Sir J. J. Thomson now proposes that some of these be considered as positively charged ions with detached valence electrons. Even the present picture is subject to change at any time, for it is necessarily founded on circumstantial evidence. Can such a picture represent reality in any way? Can we "believe in" the electrons, atoms, ions, and molecules on which the material part of our civilization has been built? The answer depends upon our definition of reality.

Professor Merritt used to tell his classes that the mind of an uneducated man had only two pigeon-holes. One was labeled absolute truth—the other absolute falsehood. Every bit of information which such a man received had to be put into one or the other of these pigeon-holes. An educated man, he said, had a whole row of pigeon-holes. At one end was one called absolute falsehood. It was always empty. At the other end was one called absolute truth. It, too, was always empty. From time to time, the educated man re-sorted the contents of the intermediate pigeon-holes, moving some things closer to one end and some closer to the other end.

There may be such a thing as absolute truth, but all we humans can hope to do is to get a workable approximation to it. This is the case, not only with the theories of the science, but also with the so-called "facts" of every-day life. Even the things whose existence we count as most sure are no more real than are atoms, ions, and molecules. Our ideas of the sun and the stars are based entirely on circumstantial evidence. None of us have ever touched the sun nor held a star in our hands. We see light coming from some point in the sky and the position of the point seems to move from minute to minute. We examine the light with the instruments of the astronomer and of the physicist. But these evidences are only circumstantial. We reason from them that there is a glowing body somewhere in space, and we call it a star. Another glowing body, apparently larger to the eye, is said to be smaller than the smallest star, and to shine by reflected light. We call it the moon. But all this is circumstantial evidence. Not so many years ago the earth was thought to be flat—the sun and moon were huge lamps dragged across the sky by horses, and the stars were little holes in the floor of heaven through which the lights of glory shone. With additional (circumstantial) evidence the picture has been changed to a round earth spinning on its axis and moving once a year around the sun—the moon revolves about the earth, and the stars are remote suns. The change in our notions of the heavenly bodies is considerably greater than the change in our notions of atoms. Do the sun, moon, and stars really exist? If our answer is "Yes," then we must say that electrons, atoms, ions, and molecules really exist.

HOW TO GET CHEMICAL PUBLICITY*

Thomas F. Murray, Jr., Eastman Kodak Co., Rochester, New York

A chemist getting publicity for chemistry is like an Armenian getting publicity for the starving Armenians. In each case the cause is a good one, deserving of publicity; but in both cases the authors find it difficult to put their programs across with the editors. The reasons for this are easily understood. If the Armenian sends his story to an Armenian paper, it is practically worthless, for the people to whom he appeals are the very people whose condition he wishes to improve. If he sends his story to America where there is the wealth to alleviate the cited distress, his effusion is worthless, for the editor does not read Armenian, or if he does, by chance, the bulk of the subscribers to the paper do not, and although the editor might be able to translate, he never does.

The first point to remember in publicity, then, is to write in the language of the people you wish to reach. The newspaper editor may himself know chemistry, but he will publish only such stories as are within the understanding of those readers who are, at most, only a little more intellectual than the average. The newspaper teaches, that is why it is read; and because it teaches slowly, it maintains its popularity.

The second point in publicity is that the story must be of general interest. To be of news value, the story must contain important facts not generally known, and it must be built around a subject about which the general public wishes to hear. The weather prediction for tomorrow is news, but an article on the weather of yesterday is not news unless the weather was extreme, in which case the story is based, not on the weather, but on the havoc wrought, or on a comparison of the weather with similar or opposite extreme conditions at other times or in other places.

The subject of a story may be a person, a report of progress, or an accomplishment. It may even be the report of a failure. Very often failures have more news value than successes. This is especially true when failure is unexpected, yet untrained newswriters frequently do not realize this fact.

The story is told of a very fashionable wedding that was to take place at some distance from the metropolis. The society reporter became suddenly ill and a cub was assigned to cover the function, with instructions to telegraph the story in at the earliest moment. The time dragged on, but no story came. The edition was delayed as long as possible, and finally published with no story of the wedding. Later the reporter strolled leisurely into the office. The editor demanded of him why he did not telegraph the wedding story. The cub replied, "There was no story.

* Read before the Division of Chemical Education of the A. C. S. at Philadelphia, Pa., Sept. 7, 1926.

The groom didn't show up." An unexpected result of a well-known undertaking is of the greatest news value.

The chemist deals with materials or processes that everyone uses everywhere, yet few know the stories of these common commodities. The water supply, sewage disposal, food, clothing, paving materials, the materials of which automobiles are made, the gasoline that runs them, the lubricants that they require—hundreds, thousands of things that the average chemist knows more or less about will furnish subjects for interesting stories for your local papers. Tell the people of your community what they want to know about these things. Do not tell them how conductivity water is prepared nor the ionization constant of dilute aqueous solutions of the sodium salts of the indicators. Tell them how their drinking water is obtained and purified, how its lime content, its iodides, and its other dissolved solids and gases aid in the proper growth and development of the body or make the water more palatable. Be exact where exactness is important. Say that iodides, not iodine, have been added if such is the case; and be careful to explain that an iodide is like common table salt and not a poison like the tincture of iodine in the medicine cabinet.

To secure publicity, the mechanical features of newswriting should be understood. The news story differs from the novel in that it does not lead up to a climax. The climax comes first, then the details leading up to the climax or following it are given in the order of their importance, the more important facts coming first. The basic rule for good newswriting is: "Tell it in the head, tell it in the first sentence, tell it in the first paragraph."

The contributor to a newspaper need not write the "head" or headline for his story. This work is best done by the trained "headwriters" in the newspaper office, but the contributor should remember to tell his story in the first sentence and in the first paragraph, reserving later paragraphs for the details in a descending order of their importance. A good news story is one that can be cut at any paragraph without destroying its news value or giving the effect of incompleteness.

Tell your story in simple words sacrificing scientific exactness in detail for general clearness and understandability. Study the form used by your local papers and especially note any changes which the editor makes in your stories. Editors do not have stories rewritten because there is lack of other work to be done in the office. It seems almost needless to add that the article should be typewritten on large sheets of white paper and one side only of the paper should be used.

In writing a notice of a meeting four questions must be answered in the first sentence, if possible, and certainly in the first paragraph. These questions are: Who? When? Where? What? Who will speak? When will he speak? (Giving the day, date, and hour of the lecture.) Where

will the meeting be held? What will be the subject of the talk? For the sake of publicity, there should be included in the first paragraph the name of the organization under whose auspices the meeting is being held.

In succeeding paragraphs such points may be considered as the local interest in the speaker or his subject; the relation of the speaker to any local industry. Is he or was he with a local concern or has he acted as a consultant for a local industry or for an industry which has a local counterpart?

Finally, give a short sketch of the speaker's life especially as it relates to his topic. Tell where he was educated, what degrees he has obtained, what positions he has filled, what books or papers he has published, and name the scientific societies with which he is affiliated. Most of this information can be obtained from *Who's Who*, *American Men of Science*, local friends of the speaker or even from the speaker himself, and I appeal to all of you here today to coöperate with publicity committees if requests come to you for information regarding yourselves or your work. The publicity man is potentially on the job 365 days a year getting free advertising for you, for your pet research, for chemistry and for chemists in general. Try to understand his job and lighten it by prompt compliance with his requests for information and copies of your papers.

No one likes to be told what he must not do, but such warnings are, unfortunately, necessary at times. In writing an advance notice of a lecture, *do not outline the speaker's topic*. It is a hard and fast rule of the newspaper office to "let the speaker say it first."

In writing the report of a lecture there is a choice of several beginnings depending on the general interest of the talk. The conventional way of starting the story is similar to that of announcing the lecture, that is, by answering the questions, who? where? when? what about? and then giving the most interesting facts brought out by the speaker. A second method is to begin the story with an important statement of the speaker and reserve the who? when? where? and what? for a later paragraph. A third opening and the one which is usually the most effective, is to start the story with a word, phrase, or statement that will attract the eye of the reader. If you can draw attention to your story, the chances are very good that the reader will read all of it, but if it is not attractive, if it gets away with a bad start, very likely it will go unread by the majority of people.

In most cases, the announcement of a chemical meeting is less attractive than is the report of the meeting and for this reason it is desirable to use a picture of the speaker with the announcement. The reader is attracted by the picture, sees the man's name, and then proceeds to find out why his picture is in the paper. Newspapers are using pictures more profusely than ever before and the larger papers are glad to get good sharp pictures

illustrating their news articles. Such a picture should have on its back the name of the subject and the name and address of the person to whom it should be returned.

Names of people always attract attention and get space. Sufficient proof of this is to be found in the printing of the casualty lists during the war, lists of contributors to civic benefits, and the like. Names are always good in newspaper publicity and it is really surprising to learn how many people go carefully over long lists of names to find out who among their acquaintances have been included.

Another method of attracting attention is by the position of the article in the paper. This the reporter can control only indirectly, but he should know how to exert this indirect control when occasion justifies it. The best positions are given to the longer stories. To get a preferred position for a story, make it half a column or more in length, make it so interesting that the editor will run it in full or nearly so, and submit it at least a day in advance of the time it is to be printed, giving the release date at the head of the story. A paper will never print a story in advance of its release date no matter how long before this date it is received.

If you want a long story in the newspaper of some activity of your Section, it is up to your publicity man to send the editor a long story, for while an editor may blue pencil relentlessly he never adds a jot to what you have submitted. Short notices, rewritten stories, stories which, because they are so illogically written or so unintelligible to the editor, are heavily blue penciled, and stories which are unnecessarily late in getting to the newspaper office are usually used for completing columns or are lost among the advertisements and "filler."

Do not give, anonymously, the opinion of one person regarding a talk, the report of a discovery, or any other news article in which anyone has made definite claims or statements of supposed facts. It is permissible, however, to say that several members of the audience expressed views at variance with the speaker of the evening or that Dr. Blank pointed out several mistakes in the speaker's paper or showed that the conclusions of the speaker were not in accord with the observed or with known facts, or "Following the paper of the evening, Dr. Dash mentioned some of his observations which supported the views of the speaker." Better still, quote the local men who have discussed the paper. Use names wherever possible, but be sure to spell the names correctly.

Do not be flowery. Flowery journalism is out of style. Say what you have to say in a direct, business-like manner.

Do not say that the speaker gave a good or an interesting lecture. Tell the important things he said and let the readers judge of its quality. Quote his important utterances so far as possible, remembering that the importance of them is to be judged from the standpoint of the average reader

of the newspaper and not from the viewpoint of a colleague. What is important to a scientist is frequently meaningless to the average reader. The chemist doing publicity work must listen with two ears and see with two eyes. One eye and one ear must be that of the chemist, that his own longing for new information and inspiration may be satisfied; the other eye and ear must be that of the "average citizen," the "innocent bystander," and the "man about town." These constitute the reading public. The chemical story must be told so it will interest them.

All rational human beings wonder about things. Little boys admit their lack of knowledge by asking a great many questions, but asking a great many questions is embarrassing to a grown-up. He reads the newspaper in the hope that some good reporter will answer his question before he asks it, or better still, before he realizes that he has a question to ask. Think of some of the things in chemistry that would interest you if they were new to you, and build a story around those things, remembering that the newspaper reader is far more interested in applied than in pure chemistry. Talk about the phases of a subject that have or may have industrial application; that will favorably affect the reader's pocketbook; or that will stir his national, civic, or personal pride.

Do not frighten the public. Keep them good natured or at least keep their good will. Tell the truth. Educate the newspapers readers to the fact that a chemist is a human being who is interested in making the world a better and safer place in which to live and who is making their dollars buy more of the necessities and luxuries of life by eliminating waste, improving methods, and utilizing by-products.

New York Tries New French T B Treatment. Experiments in the Calmette method of tuberculosis immunization are now underway in the laboratories of the New York City Health Department. Reports from Paris give promise of better results than any other method so far tried, according to Dr. William H. Park, director of the Bureau of Laboratories.

This method has been developed by Calmette of the Pasteur Institute. It consists of the inoculation of infants with tuberculosis bacilli taken from cattle twenty years ago. These bacilli have been kept alive for the twenty years, but in an overheated, semi-starved condition, so that they have lost their potency as disease breeders. An animal inoculated with them will not develop tuberculosis. These germs, however, still produce sufficient of the peculiar poison of the bacillus to force the animal inoculated to build up a resistance to tuberculosis without being endangered by the disease, as would be the case if virulent bacilli were used for the inoculation.

In France, Calmette is using this method to immunize infants born of tuberculous mothers. It has been used for babies to a slight extent in Canada. The bacilli are fed to the infants during the first days of their life. Up to the present, Dr. Park states, the New York City Health Department has experimented only on monkeys and calves.—*Science Service*

THE CONTRIBUTION OF ANILINE TO ECONOMIC AND SOCIAL PROGRESS DURING THE PAST ONE HUNDRED YEARS*

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The year 1926 marked the one hundredth anniversary of the discovery of aniline. The importance of this substance in the progress of both pure and applied chemistry during the past century justifies a brief account of its chief contributions to the prosperity, health, and happiness of mankind.

Unverdorben's recognition of aniline among the products of the distillation of indigo in 1826 was but the prelude to what was to follow. This was the period of dim light before the dawn of synthetic chemistry. It may be said to represent the analytical period in the history of organic chemistry when the chief concern of the chemist was to observe the behavior of natural products under varied conditions and to resolve these products into their component parts. Thus it was that Unverdorben discovered that on heating indigo at a temperature high enough to decompose it, an oil was formed which gave crystalline salts with acids. This discovery does not appear to have been very widely known or appreciated in the years immediately following. It was not until 1840 that Erdmann pointed out that Fritsche's aniline, which was obtained about this time by distilling indigo with caustic alkali, was identical with the "Crystallin" of Unverdorben. Indigo was now a source of aniline and the pioneer work to establish the properties and constitution of aniline was begun.

The basis for the economic development of aniline is found in the discovery of its relation to benzene which was, subsequent to Unverdorben's discovery of aniline obtained from coal tar. In 1825 Faraday discovered benzene in an oil obtained by compressing an illuminating gas. In 1834 Mitscherlich obtained a substance identical with Faraday's benzene by distilling benzoic acid, a natural product, with lime. In the same year he converted benzene into nitrobenzene. At about the same time Runge discovered a basic oil in coal tar and called it "Kyanol." Eight years later (1842), Zinin showed that nitrobenzene was reduced by ammonium sulfide to an oil which he called "Benzidam." Soon after, A. W. Hofmann showed the identity of Crystallin and aniline, which had been obtained from indigo, Kyanol, which had been obtained from coal tar, and Benzidam, obtained from nitrobenzene. The last link in the chain of evidence connecting aniline and benzene was furnished when Hofmann discovered benzene in coal tar. The stage was finally set for the subsequent synthetic period in chemistry when Bechamp succeeded in reducing nitrobenzene to aniline with iron and acetic acid.

From the economic point of view the discovery of mauve by Perkin

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in 1856 marks the beginning of the synthetic period. A new commodity had been created. A demand existed for it. No dye then available would give the particular hue produced by this new synthetic dye, and, more important, this particular hue had been long desired. It was fortunate that this new product found a ready market. In the face of the tremendous difficulties that had to be overcome in starting the synthetic dye industry, it is questionable if mauve could have competed successfully with a natural product giving the same hue and having similar properties. Think of the undertaking! Only the courage and energy of youth could have succeeded. No available raw material, no equipment, no manufacturing technic; these were handicaps to strike fear into the heart of the bravest. But young Perkin never wavered. One by one the obstacles fell away and the infant synthetic dye industry was established. Perkins' success encouraged others to enter the field and soon aniline and its derivatives were subjected to the action of a variety of agents under varied conditions and new dyes produced in ever-increasing numbers. The industrial achievements were accompanied by brilliant investigations of the products and the science of chemistry was greatly extended and enriched.

The majority of the aniline dyes in the several important groups were discovered in the period 1856 to 1906. Many thousand products were made. Not all of them were of commercial importance. The number of products in the market during the latter part of this period was greater than needed and many were ultimately eliminated. Of the several hundred synthetic dyes in our market today, over fifty per cent of them are derived from aniline, and of these aniline dyes over ninety per cent were discovered in the period 1856 to 1906. Most of the important ones were discovered prior to 1895.

The colors produced by aniline dyes have played an important part in the economic and social progress of the world during the synthetic period. Millions of dollars of business have been created and life broadened by the experience. No adequate evaluation of the contribution of aniline to economic and social progress can overlook the effect of the synthetic dye industry on inter-related industries and on the methods to secure business. What, for example, is the value of color in advertising? How much more would have to be paid for the same results if only black and white were used in advertising matter? How much more effort would be needed to carry conviction and get the business? The dye industry is itself a comparatively small business but the industries it serves are the foundation of world prosperity.

Health and happiness are indispensable to world prosperity. Deeply rooted in the soul of humanity is the desire to banish pain and suffering. The value of health and happiness in economic and social progress may

not be appraised in dollars but it is none the less real. How much pain and suffering have been relieved by aniline products! The synthetic dye industry resulted from the investigation aimed to produce a drug the equal of quinine. This work unlocked the treasure box of synthetic chemistry and produced dyes which are capable of producing all kinds of colors on all kinds of fibers. While the original purpose is still unfulfilled and no product has been obtained which is the equal of quinine in all respects, aniline has been converted into several important drugs which are widely used to relieve a variety of ailments. These drugs are among the most important antipyretics, analgesics, and antirheumatics in use today. A study of these products and their behavior in the human body has led to a better understanding of the nature and limitations of the human mechanism.

The synthetic period in the development of aniline and its derivatives is divided into two periods—1856–1906 and 1906–1926. The former period is characterized by intensive synthetic work and the formulation of the fundamental principles of the chemistry of carbon compounds. Modern theoretical organic chemistry is based on the structural idea of chemistry as formulated during this period. Most of the important aniline dyes and drugs were synthesized in this period. The latter period is characterized by an extension of the use of aniline beyond the narrow borders of dye and drug chemistry and by the development of aniline and its derivatives in the United States. It is during this latter period that aniline was applied in the acceleration of the vulcanization of rubber and in the preparation of antiknock motor fuels. The progress made in the manufacture of rubber products is shown by the comparison of the mileage obtained with automobile tires today and that obtained with similar classes of tires five years ago. Millions of dollars have been saved to the automobile public by greater mileage on tires and part of this saving is due to the use of aniline compounds in the manufacture of the rubber. The achievements in synthetic chemistry during the synthetic period under review have been marvelous. New industries have been created and their products have contributed largely to the necessities and luxuries of life, with its ever changing demands; the scope of scientific investigation has been widened, but above all, the science of organic chemistry has been erected on a firm foundation and has become the backbone of modern chemistry.

Eastman Awarded British Photographic Medal. George Eastman, of Kodak fame, is the latest recipient of the Progress Medal of the Royal Photographic Society. The medal was awarded for "his inventions, researches, publications and other work." The scientific work accomplished in the Eastman Research Laboratories, at Rochester, N. Y., which he established, was said to have been a large factor in determining the award of the medal.—*Science Service*

CHEMICAL PLANT DESIGN: A CHEMICAL ENGINEERING COURSE*

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Chemical plant design as part of the chemical engineering curriculum is given in only a very small percentage of institutions which presumably train men for the chemical and allied industries. Its value as a summation and correlative course can be equalled by very few engineering subjects. Its emphasis on the practical side closely connects the student with industry. The viewpoint from the financial and economic phases causes the subject to be ever alive, progressive, and necessarily up-to-date.

Practically all of our engineering teaching is done from text-books. All of us are familiar with the statement that it takes ten years to get facts and practices into text-books and twenty years to get them out again. Far too often is this criticism true. Seldom in his engineering course does the student come in contact with the printed matter which is up to the minute—manufacturers' catalogs, reports of industrial research, and experimental work by equipment makers, etc.—the huge mass of information termed "trade literature." The work of chemical plant design forces the student into useful acquaintance with this source of industrial practice.

The previous training of the student has given him a grounding in physics, mathematics, electrical engineering, industrial chemistry, mechanics, power, metallurgy, and chemical engineering unit processes. These subjects are but little correlated in their presentation. Their specific application to specific problems are but slightly touched in connection with the economic side of actual industry. Chemical plant design converts them into a coördinate whole for the chemical engineer—as expressed by one student, all of the rest of the engineering course was just preparation for this one.

The language of chemical plant design is a universal one—that of engineering drafting. It is assumed that the student is sufficiently apt in the use of this mechanism of expression of ideas and directions. Previous training in drawing is presumed. Chemical plant design is not a drafting course any more than industrial chemistry is a course in English; the vehicle or means of expression is entirely subordinate.

Design courses, in general, may be divided into three different types. The broadest and most useful variety employs the industry as a unit. The second type is a subdivision of the first and employs a specific plant as a unit. The third type is a subdivision of the second and employs a specific unit process or a single piece of equipment as the unit.

In the first type, of course, the survey of the specific industry (either

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selected by a group of students and approved by the instructor, or assigned by the instructor) is the starting point. The economics of the industry—the annual production, consumption, imports and exports, sources of raw material, location for existing plants, the history of the industry, its economic importance, product distribution, the effect of a new plant on the industry, the disposal and utilization (if possible) of by-products, etc.—are first investigated. Governmental reports of the Department of Commerce, the Federal Trade Commission, the Tariff Commission, along with data available from the work of various trade organizations furnish the sources of material for this part of the work. The majority of students have had little need to come in contact with these fields of information previously. Those who have, perhaps thought it dry as dust for they could not see a specific application to their own work.

The student's attitude should be that of an engineer connected with a group of men and capital desirous of entering some established industry or organizing a new one. The specific industries for which plants are to be designed are either selected by groups of students working together, and approved by the instructor, or else assigned by the instructor to these groups.

After the survey of the industry has been completed and reported, the plant size, expressed in terms of quantity of product, is determined. From economic studies, sources of raw material, availability of labor, disposal of product, freight rates, etc., the plant location is determined. Capital to the extent required is assumed to be available. The problem then resolves itself down to the design of a specific plant of definite size in a definite location. The type of plant, the completeness or incompleteness of its mechanically handled operations, the type of process used, the equipment specified, the kind of power used, etc., will be determined by availability, original investment costs, operating costs, location of raw materials, and the plant location. It is interesting to note, as an example, that even at large hydroelectric power centers, where power is "inexpensive," that it is cheaper to employ coal as a fuel for low-temperature heating than it is to use electrical energy for the same purpose.

It is understood that this first type of course can only be applied in the case of men with exceptional preparation in chemical engineering. It is believed that only one engineering school gives this type of course. That school is connected with a large eastern university. The engineering course there is of six years' duration.

The design of a specific plant, definitely located, of determined size, to make some definite product or products, is employed as the unit of the second type of plant design course. The problem involves the selection and layout of equipment from the chemical, engineering, and financial phases of the situation. In chemical plants, knowledge of the chemical

resistance of engineering materials of construction becomes of great importance. The emphasis should be placed on the dollars and cents aspect at all times. After a short while the student may suddenly realize that the equipment he had seen in plants he visited and thought clumsy and stupid, was, from the dollars and cents viewpoint, exactly suited to the job. Conversely he may find that apparatus in other plants that he thought clever, was economically unsound. Shortly there will come the comprehension that he is working not only with apparatus built of engineering materials, but with dollars which he is condemning to grow or to die.

As a subdivision of the unit plant, there is a third variety of course still more limited in scope. The individual piece of equipment or a single unit process is chosen as the unit. The problem is either to select the apparatus in all its details or to design the same. Provision must be made for its setting up in the plant in its appointed place. Determination is made of its physical tying-in with the rest of the plant, its piping, driving mechanism, control, operation, etc. Familiarity with the catalogs of manufacturers and ability to use trade literature becomes important. Complete acquaintance with the details of the process, its conditions, corrosion phenomena, physical characteristics of the materials handled, must all be learned before equipment can be selected or designed. Often, in industrial work, considerable preliminary experimentation on the material, process, and equipment is necessary.

The approach to the entire course, no matter which type or subdivision is employed, must necessarily be through the avenue of unit processes. Fundamentally filtration is the same whether encountered in the manufacture of heavy chemicals, pigments, or dyes. Evaporation, as a process, is the same, irrespective of the product made in a particular plant. Of course, it is understood that the specific equipment for the unit process may be quite different at times. The difference is in details, not in fundamentals.

The "flow sheet" or chart of operations affords a starting point for the plant. Obviously the student must acquaint himself with the industrial chemistry of the process, with all its twists and turns. Visits to plants in operation will be found very helpful. A tonnage flow sheet, showing the amounts of materials to be handled at each step of manufacture, is prepared. An equipment flow sheet showing the type, variety, and size and number of pieces of apparatus for each portion of the process, carries the work still further. Detailed selection of equipment, with complete specification for accessories follows in natural order, as do the bills of material for construction. The selected apparatus then has to be coördinated into an operating group. The physical dimensions of the machines, etc., are known and the layout of the plant can be prepared. The large number

of conditions to be met in making a layout can be appreciated only after considerable experience. A good engineering instructor can point out and observing students can usually see the obvious desirability of providing sufficient space to work, free flow of materials, proper ventilation, observance of the building laws and fire department ordinances of the municipality, agreement with the underwriter's rules, etc. The most economic layout, however, can not be so readily seen. From the viewpoint of operating cost, one of a number of layouts will be better than the others. It is very likely that the student may produce half a dozen layouts before satisfaction is reached. Machines must be driven, power transportation and transmission have to be taken care of, and sources of energy provided. Liquids and gases may need to be moved from place to place; piping systems must be calculated and located most efficiently. Solids must be transported in the plant and conveyed from place to place through the various stages of plant operation. Heat energy, or its removal, must be provided where desired for use. Raw material has to be gotten into the plant and finished product shipped out for disposal. Waste and by-products bring along their own problems as to the best ways of handling them.

The layout concluded, detail design and assembly drawings follow. These are started only after the layout, if both plan and elevation have been satisfactorily completed. Provision is made for the erection of the plant and its control in actual operation. Administrative control, control of labor, time, material, temperature, moisture, light, power, sanitation, waste disposal, and hazards are carefully planned. The whole mass of data is then coördinated into the finished plant design.

At first glance it would appear that the design of chemical engineering plants, owing to the multiplicity of the processes involved and the apparent highly specific nature of almost every case, is a subject impossible to treat as a coördinated whole. Certainly at first glance it does not look like a teachable subject unless given by a "professor of things in general." But a closer view of the field will disclose a remarkable simplicity of the underlying structure, obscured it is true by an infinity of detail, but everywhere yielding to a common system of analysis. The plant embodying truly unique features is rare indeed.

Ordinary structural design is in the last analysis a question of protection from the elements; ordinary machine design is a question of pure mechanics, but plant design is a problem in coördination. There must be no loose ends, no blind alleys.

Summary

An attempt has been made to show the value of courses in chemical plant design in the chemical engineering curriculum as a useful mechanism for coördination and correlation of the students' engineering training in

seemingly loosely connected fields. Types of courses now in use have been briefly outlined. The incorporation of courses in chemical plant design in our engineering schools and their intense utilization would not only connect the student more closely with industry but cause him to realize that the only reason men enter business and industry is to cause money to earn more money. Plants are, after all only mechanisms for the growth of capital. Chemical plant design causes engineering students, as does no other course, to select and constantly maintain a definite point of view—the first duty of an engineer.

In the institutions in which the course, in one of its varieties, has been given, it has produced gratifying results, satisfactory in its entirety to both the students and the instructor.

Meningitis Vaccine Stays Epidemic. Modern science is taking some of the horror out of another dreaded disease. On a study tour in Africa, Prof. R. Bruynoghe of the department of colonial hygiene of the University of Louvain, had a first-hand opportunity to observe the effect of anti-meningococcus vaccination in a sizable epidemic of cerebro-spinal meningitis.

This disease, though normally only slightly infectious, causes universal alarm when it assumes epidemic proportions. Patients undergo fearful pain and death usually ensues within a few days. In times past the fatality often ran over seventy per cent. The development of a specific serum, however, has brought this terrific rate down to less than twenty per cent, when its use is begun early enough after the onset of the disease.

About 15,000 persons during the African epidemic were given three injections of serum under the skin at intervals of eight days, while the disease raged among workmen in the mines at Karanga in the Belgian Congo. In most cases, says Prof. Bruynoghe, the inoculation brought only mild discomfort and the epidemic was brought to a full stop.—*Science Service*

Many Psychology Courses Bad, Educator Declares. An investigation of psychology courses in 420 colleges and normal schools in the sixteen southern states and the District of Columbia is revealing deficiencies of a serious character, according to Dr. Joseph Peterson, professor of psychology at the George Peabody College for Teachers.

Dr. Peterson, who spoke before the American Psychological Association in Philadelphia recently, said:

"Numerous institutions are advertising courses in psychology which they are totally unqualified to offer, and they are thereby inducing hundreds of young men and women to spend time and money in efforts that are worse than wasted.

"The results are sure to be bad in at least two senses. First, the students are deceived by failing to get the training that they seek and for which they pay, and often they learn only when they go to higher institutions for more advanced training that they have lost their time and means and are really not prepared for advanced work. Their disappointments in such circumstances are sometimes grave. Secondly, the insipid text-book content, often derived from out-of-date books, which is usually taken uncritically and passively, and memorized for examinations, creates a dislike for psychology and produces a scarcity of workers in a field of science that has doubtless great promise for the betterment of mankind."—*Science Service*

A SECONDARY COURSE IN INDUSTRIAL CHEMISTRY*

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For the last three years we have been enjoying the JOURNAL OF CHEMICAL EDUCATION, and I am sure that we have all derived great benefit from it. The objectives of secondary chemical education have been admirably presented in its pages. But only a few articles, notably that of Dean Munroe,[1] have drawn attention to the fact that chemistry may be studied "for its economic value; that is, as furnishing a means of livelihood" and none expand upon this objective. In all the articles published in the JOURNAL, the vocational side of chemical education has been almost ignored.

Such a situation is to be expected in an undemocratic scheme of education like our own. "Our system of education has been in the past, and even now is class education. It has been aristocratic, highly specialized, and narrow in its conception. It has been primarily for the children of rich people, with the primary objective, beginning in the elementary grades, of college entrance, with a strong emphasis on the classical, a lesser emphasis on the scientific, and very slight emphasis on the vocational."[2] "Of 1000 pupils in the fifth grade, 830 pass to the sixth grade, 634 of them enter the eighth, 342 of these reach the high school, but only 139 graduate; and while 72 of the original 1000 enter college, just 23 finally finish."[3] One million American children leave school annually at fourteen.

The high-school teacher is interested for the most part only in turning out a better product for the college, a product which can successfully pass the sacred entrance examinations. He is oblivious to the pandemic aspects of chemistry which Dr. Bancroft[4] recently presented so well. Many high-school teachers turn a cold, fishy eye upon the senior who is not going to college, as unworthy the expenditure of their valuable time.

For the most part, chemistry is given only in the final year of the academic high school, after two-thirds of the boys in chemical laboratories and plants have gone to work. I have good evidence, through a questionnaire upon which we are still working, that two-thirds of the laboratory boys in chemical plants leave high school before chemistry is given. The remaining one-third are taught a sort of chemistry which gives them very slight advantage, if any, over those who have had none at all. The testimony of many laboratory foremen and chief chemists will bear me out in this. Chemistry never has a chance to inspire the great army of "drop-

* Paper read before the Division of Chemical Education of the A. C. S. at Philadelphia, Pa., September 10, 1926.

[1] THIS JOURNAL, 2, 67–72 (Jan., 1925).

[2] Payne, "Administration of Vocational Education," McGraw-Hill Book Co., New York, 1924, p. 7.

[3] *U. S. Bur. Educ. Bull.*, No. 34, 1920.

[4] THIS JOURNAL, 3, 396–400 (April, 1926).

outs" who are killed off in the freshman year by formal Latin and algebra. How can this great group ever be brought to realize the importance and usefulness of chemistry in their daily lives?

Judging by the papers in our JOURNAL, the college or university teacher is mainly concerned with getting a better product from the high school. He turns back teachers to the secondary schools who have had at best an average of two years chemistry, theoretical rather than broadly general and industrial in its nature.

More teachers in our high schools and industrial schools should have the four-year chemical engineering course as background, coupled with several years of industrial experience, rather than one or two years academic chemistry and qualitative analysis. How can a teacher thrill a pupil with the possibilities of chemistry as a career who has had no contact with the industry, who has never been outside the monastic confines of the classroom?

Gentlemen, some of you have been too anxious to produce chemical American Beauty roses, pruning off the many buds who do not have in mind the goals of college entrance or research. You have been so anxious to "train for leadership" as you call it, that you have created a sort of Mexican army, all colonels and no privates, all leaders and no followers. This last year only 4500 students of chemical engineering were registered in the technical schools of this country and this means less than 900 graduates, far too few for the demands of our growing chemical industry.

Now, in chemical and metallurgical centers the industries require a great number of laboratory assistants who are capable of doing routine work accurately. These assistants must be paid at a low rate because of competition. Naturally the positions are filled by boys and girls, chiefly the former. These very minor "chemists" have, in some cases, left school before completing the 8th grade and have drifted into the work they do simply because they happened to run across it. These occupations do not appeal to high-school boys except perhaps as a stop-gap during the summer. Owing to the casual way in which these boys enter the industry there is naturally a very high rate of turnover. They drift from job to job until they acquire enough skill to hold a place and yet they are important to the industry because the routine analysis which they are called upon to do is sometimes the basis upon which large operations are conducted. As an extreme example of this I knew of the case of a boy who was on night shift and in charge of Kjeldahl determinations upon which material valued at $4300 daily was dependent, yet this boy slept in the laboratory loft and spent most of his days about local gambling joints, making all his determinations by the "graphite" method.

Obviously there is a misfit here and it is not to the advantage of either the industry or the boys to leave things as they are. It is not necessary

to force the ordinary high-school boy to such positions because he is usually able to go on to something else, but it ought to be possible to train the boy who works to fill his position more intelligently and save the wastage which is so characteristic of the present situation.

There are few reservoir classes from which a better type of boy can be drawn for this sort of work. Such classes can and should be established in every chemical, ceramic, and metallurgical center under the Smith-Hughes Law, not only to supply laboratory workers, but also to aid in training helpers, operators, and minor foremen who will have a thorough chemical background. This is the only way which will provide suitable material for future promotion from the ranks. And we believe that such promotion is as necessary and logical in the chemical industries as in any others.

We believe that "the men educated for the bigger positions in industry in evening schools, in continuation schools, in apprentice schools, in correspondence schools, and in shop schools will outnumber those educated in colleges and technical schools nine to one."[5]

The vocational school has a chance to salvage the "drop-out" and show him that he can become a worthwhile cog in an interesting and ever-changing industry where the baton is in his knapsack, now as ever. Our vocational schools begin to take as their motto "Any one, at any time, for any length of course." Here "no eager student is met by the questions: 'Where is your high-school diploma?' 'How many credits have you in mathematics, foreign languages, and literature,'"[6] and with Marietta Johnson of the Fairhope School we too "refuse to grant a monopoly of any subject to the college."

A vocational school is able to weed out undesirables and help the plants avoid part of the expensive hire-and-fire methods of getting trustworthy employees. And from their contact with industry and with technical men, new ambitions are awakened in many boys who turn toward the goal of the Engineering School with understanding and determination. Cooperative part-time classes are able to keep many good boys in school who would drop out either through lack of interest or lack of funds. This type of boy at this stage does not become interested in night school or correspondence school courses.

Under the Smith-Hughes Law, a teacher in a vocational school may present any material "designed to enlarge the civic intelligence" or "to enlarge the vocational intelligence" of the pupil. The work may be either trade extension, trade preparatory, continuation school, or coöperative part-

[5] F. T. Jones, White Motor Co., "A Way in Which Schools Can Operate with Industry," a paper given before the National Society for Vocational Education, Buffalo, N. Y., Dec. 6, 1923.

[6] *Voc. Educ. Mag.*, **11**, 1124 (1924).

time work. It is the latter which we are carrying on at Wilmington. We believe that boys chemically trained are necessary as a future source of operators and foremen for the chemical industries of this community, though some will remain in the laboratory.

In and about Wilmington, the du Pont Company has the largest plant employing boys of this type. There are laboratories of the following kinds nearby: dyes and explosives, textiles, paper fiber (including impregnated fiber), artificial silk, iron and steel, brass and bronzes, heavy chemicals, oil, glazed kid, tanning materials and there is also a certain amount of sanitary and public health work.

At Wilmington, any boy over fifteen and one-half years who has passed the eighth grade, who can pass suitable intelligence tests, and who is able-bodied can enter the course. He is put on six months' probation and may be turned back to the academic school if unsuitable. He can enter for short unit courses, for two years' coöperative work, and in some cases can take it along with high-school work for graduation and college entrance. He can secure a maximum of eleven Carnegie units toward high-school graduation, nine in industrial chemistry and related work and two in English. With this goes a Delaware State Vocational diploma. To graduate from high school eight additional units must be secured.

Boys are entering at any time and the work is, therefore, given in individual lessons. Class instruction is impossible except as accidental groups form who are interested in the same topic. The boy who works in dyes or intermediates is given units directly suited to him, while the boy in an oil or steel laboratory is given quite different work. Part of the boys work under apprenticeship agreements. We try to follow the principle that "in proportion as training is given at the time it is really needed does the mind of the learner go along in its thinking processes with that of the teacher."[7]

With this in view, a boy is taught first of all to take accurate samples, to weigh on the chemical balance, and to clean and store porcelain and glassware. We aim to give the young worker an understanding of his work as he needs it and not months before or after. To this we will add all the chemistry, as science related to his work, which he can absorb and understand. The requisites for the creation of a chemical industry are discussed at an early period.

Job analyses of the work of a laboratorian have been made both from the viewpoint of the plant supervisors and of the laboratory foremen or chief chemists. These are to be set up as a separate article.

We began our work with the first job analysis as our basis, making our course strong in elementary and related chemistry. But the foremen insist that laboratory technic and skill shall be emphasized, and not

[7] C. A. Prosser, "Pusher Education," *J. Voc. Educ.*, **2**, 927 (Sept., 1924).

related science. These objections we are meeting by breaking up the work into short unit courses instead of a two-year course and trying to furnish boys whom we can guarantee to sample, weigh, and titrate accurately, before giving many related science units to them.

However, we recognize that the viewpoint of the foremen or chief chemists is toward production solely and not toward the future advancement of the employee or his future usefulness to the employing company. We feel that an over emphasis in this direction is to be avoided. A company should ask itself, "Where are our operators and minor foremen coming from ten or fifteen years from now? Can we train them ourselves after securing them by the hire-and-fire method?" The employment managers of large chemical companies are even now putting these questions to their managements and emphasizing the need of plant policies which will support vocational education in their communities. They are aiding employees to attend night or correspondence classes. They recognize that with restricted immigration, the community must train its skilled labor at home and that the bulk of this skilled labor will remain in the community.

The average age of our boys is over seventeen. They vary from fifteen-year old freshmen to high-school graduates. None have had previous instruction in chemistry.

Regular visits are made by the instructor to the various plants of the community to find new jobs for unemployed boys, to promote the work of the course, to settle any differences or dissatisfaction between employer and boy, and to learn of any new subject material or of any need of the boy which can be corrected by instruction.

As with any new project of this kind, hurriedly placed in operation, there have been some mistakes in placement through lack of time to study the boys thoroughly. But it is believed that misplaced boys gradually can be shifted without causing friction with the employer and that boyish restlessness and desire to change can be greatly checked.

As stated above, the work has been given upon a basis of science related to the trade. But, as rapidly as possible, it will be shifted to a job basis. For instance, after a "bottle washing" stage, a boy is usually given weighing and titration or distillation work. He must, therefore, be trained to weigh accurately upon the chemical balance at once. As there is much difference in methods in various laboratories, the boy must learn speed and deftness in actual practice, "on the job." He can then be taught to titrate solutions of acids and bases, developing along with this the nature of acids and bases, indicators and all the necessary information for a real understanding of his work. Related science as to the nature of elements, metals, non-metals, etc., can rapidly supplement the job instruction. He will at the same time be taught the terms of his work—the names of apparatus and chemicals, and necessary safety and hygienic precautions.

The operations of the plant, such as weighing, grinding, filtration, and distillation are put into practice in various ways. Related mathematics is given, covering decimals, ratio, and proportion, logarithms, areas and volumes, the use of the slide rule and calculating machine, the method of mixtures, and any other chemical calculation methods needed in plant work. A boy should become able to do good free-hand lettering and understand blue prints and flow sheets.

Boys employed in organic chemical plants, or where the processes of organic chemistry are mainly in use are allowed to prepare simple organic chemicals related to their work early in the course and they are given related science instruction in elementary organic chemistry as soon as they have a basis sufficient to undertake it, *i. e.*, after a short study of the general principles of non-metals and industrial metals has been made. Boys employed in general or metallurgical laboratories will be given a more extended course in the study of the metals as in the operations of industrial chemistry.

Content of the Course in Related Science and Mathematics

First year—First term: Certain preliminary instructions are given the pupil as to finding chemicals and apparatus on the open shelves, bending glass, boring corks, setting up apparatus, recording experiments, and avoiding accidents. Carbon is then taken up as being a tangible non-metal, the basis of the organic chemical industries through destructive distillation. Its presence in nature, its properties as an adsorbent and reducing agent are studied, as well as some of its simpler compounds.

Silicon is studied because it is a border line element between metals and non-metals, its use in cement, steel, and as a rock former being emphasized. Iron is considered as the most useful metal, salts of iron are prepared, its two states (ferrous and ferric) are noted, and a study of iron and steel production made. Oxygen, hydrogen (water and its properties), nitrogen, valence and simple equations, sulfur, the halogens, phosphorus, mass action, hydrocarbons and nitration, sodium, and potassium conclude the science units given during the first term.

In related mathematics the use of metric units and decimals is first taken up, then ratio and proportion, percentage, interest, mensuration; thrift is emphasized, the importance of savings and building and loan accumulation being stressed.

First year—Second term: A short study of copper, lead and silver, zinc, aluminum, calcium, nickel, manganese, and chromium is made and a beginning with the scheme of qualitative analysis. In his plant work, the pupil has by this time found out the need and use of logarithms—except where a calculating machine is used—and often asks of his own accord to be taught their use. The need of mathematical training de-

velops naturally through his experience. Logarithms and the mathematical relations of the elements are taught, tying up with the idea of valence and the writing of simple equations. It is easy to relate the previous work in ratio and proportion to this. Problems can be formulated from actual laboratory conditions. The method of mixing solutions of varying strengths to get a definite strength is also taken up here.

By this time the average boy should be past the bottle-washing stage and intrusted with weighing, titration, or distillation work or other work of increasing difficulty or importance. He is, therefore, taught the theory of titration, the use of various indicators, how to prepare volumetric solutions and at least the theory of their standardization. As type jobs he carries through the operations and calculations of alkali and carbonates in soda ash, ammonia by the Kjeldahl method, and the determination of mixed acid composition.

In 1924–25, reports were made by students upon the lives of famous chemists. These were read before the class and discussed by class and instructor. The idea was to interest them in engineering and chemical projects of current industrial interest. Emphasis was placed upon the need of preserving the thought while condensing these articles into short reports for class discussion. This was outside the conventional English class work.

Second year—Third term: The class will divide according to their work, part going into elementary organic chemistry. The rest will take up the conventional separation of the metals, also equations of oxidation and reduction.

Second Year—Fourth term: Two units of related physics will be given, humidity as affecting chemical work, elementary electrical applications and further organic units. The general group will continue with a study of acids, simple alloys, the writing and balancing of oxidation and reduction equations, the electromotive series of metals, the periodic law, colloids. A review of any necessary mathematics will be made. Organic students will study the theory and use of the nitrometer (especially the du Pont form), fractional distillation, melting and setting points, some of the methods of purifying organic compounds, and additional time will be spent in the preparation of simple aromatic compounds. Metallurgical students will take up the preparation and standardization of permanganate, thiosulfate, iodine and bichromate solutions, using them in iron, calcium, bleaching powder, and manganese determinations.

Slow students will be required to complete the units in night school during the third and fourth years of the course. In the last term of night school, a course in job analysis (25 hours) will be given. Keener students will be given review or advanced work.

Descriptive sheets and references concerning mechanical and chemical

operations will be given the pupil as the need arises. Much of the instruction upon these will be gained directly or indirectly while at work and, unless special situations arise, need not be given in the class-room. Pupils will be encouraged to develop extra projects of their own which may be of interest to them, such as the preparation of acetanilide from aniline and acetic acid, metanitraniline from dinitrobenzol, thiocarbanilide from aniline and CS_2, or soap from kitchen fat and alkali. Malachite green and other dyes have been prepared by students.

Now, to summarize: the chemical industries have in many cases a high rate of labor turnover in their control laboratories, due to an unselected class of incoming boys who are in most cases untrained, and the consequent low starting wage which can be offered them. There are very few reservoir classes from which a better type of boy can be drawn. Vocational groups are needed for this sort of training in chemical and metallurgical centers among boys who ordinarily do not reach high school, who are not able to afford a full high-school course or who drop out during the freshman year through lack of interest. Coöperative part-time courses are preferable to full-time courses as they enable the boy to earn and gain experience while receiving additional training in the class. Girls as well as boys may benefit in this sort of training.

The public schools, the industries, or both should maintain Smith-Hughes and vestibule classes for the future workers in chemical plants. Pandemic chemistry should be given in the first year of high school, along with other "industrial arts" subjects to attract boys and to inform them as to the nature of chemical work. From these classes, the most fit can be taken over into the coöperative part-time and full-time classes for chemical work, and finally through the night school brought up to the point where they can qualify as analysts, operators, and foremen.

To quote David Snedden, "Given opportunities of the kind here suggested—we are justified in assuming that the more ambitious and gifted boys will push on from level to level. As they reach twenty-two to thirty years of age, some of them will become aware of their natural powers of leadership. They will see possibilities of becoming foremen, inspectors, salesmen, managers, inventors, technical specialists. They will attend special upgrading schools, correspondence schools, or else will take a year or two to go to a technical school or college in the field of their special interest.

"Is not the plan of vocational education here suggested the only one which will assist our workers in modern highly specialized enterprises?"[8]

Already the public is beginning to demand "more education for less money"[9] and unless chemistry teachers in the secondary schools, along

[8] *Survey*, **43**, 704 (March 6, 1920).

[9] Governor Hartley to the Washington State Legislature, Nov., 1925.

with other teachers, pay far more attention to the needs of the eighty per cent who do not go to college and less to the twenty per cent who do the public will require a harsh reckoning with them.

My own experience has brought me to believe that just as the mathematics teachers are reorganizing their work and giving unified and combined mathematics courses in secondary schools, instead of pigeon-holing them as algebra, geometry, and trigonometry, the science teachers must finally come to a four-year combined science course on a unit basis to reach the "drop-out" who otherwise will get few rudiments of physics or chemistry at all. The general science course does not serve the purpose.

In chemical and metallurgical centers the remedy is pandemic chemistry in the first year of high school, and the unhampered vocational school.

Gentlemen, you cannot sit longer in Olympian calm, ignoring those who never reach your class-room or sneering at them for their failure to do so. You must carry chemistry down to them.

School Libraries Need More Trade Journals. A plea that high-school libraries allot a larger portion of their funds for scientific reading material to the purchase of trade journal subscriptions was made by Dr. Hanor A. Webb, professor of chemistry at the George Peabody College for Teachers.

Speaking before the American Association for the Advancement of Science in session at Philadelphia, Dr. Webb stated his belief that trade journals rather than books on applied science should form the bulk of such reading material, especially in schools where vocational guidance is practiced either formally or informally.

The trade journal, he believes, will provide more strictly current information, better descriptions and illustrations of present practices in the use of raw materials, modern equipment, and finally a more human aspect of industry.—*Science Service*

Spectrum Lines Reveal Calcium Clouds in Space. Two dark lines in the rainbow-like spectrum of certain very hot stars, obtained by passing their light through the prisms of a spectroscope, indicate the presence of calcium clouds in space and not directly connected with the stars, Dr. Otto Struve, of the Yerkes Observatory, recently told members of the American Astronomical Society.

Dr. Struve has attempted to learn whether these so-called "detached" calcium lines reveal any of the properties of the calcium clouds. For this purpose he has studied their intensity in many spectral photographs, mostly of stars whose surface temperatures are greater than 17,000 degrees. He has found that the lines are much more pronounced in stars farther away from the sun than in our nearby neighbors, up to a distance of about 700 or 800 parsecs, a parsec being the astronomer's unit of measurement. It is equal to about 206,000 times the distance between the earth and the sun, or about nineteen trillion miles. Beyond 700 or 800 parsecs, however, the indications are that the lines are weaker, as in the nearer stars.

This distance at which the lines are most intense, Dr. Struve said, is about the same as the distance of the boundaries of the local cluster of stars, of which our sun is a member, near its center, so that his results indicate that these calcium clouds are most abundant near the borders of our local star cluster.—*Science Service*

THE CULTURAL VALUE OF QUALITATIVE ANALYSIS

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The contributions of chemistry to civilization and the value of some knowledge of chemistry in the comprehension and promotion of our present form of civilization are subjects of daily thought and consideration. The growth of new knowledge in chemistry has, however, been so rapid and mushroom-like and we have been so much preoccupied in our attempts to keep some kind of order in this vast accumulation of knowledge, that we have difficulty in maintaining our perspective. The tremendous utilitarian applications of the chemical viewpoint in life and industry are so clearly obvious and far reaching that many of us have forgotten that chemistry lends itself ideally to a diversified training and discipline in the scientific method. This was commonly recognized before the serious overgrowth of chemical knowledge converted the study of chemistry so largely into a memory training school.

Man in his evolution has perhaps never achieved any greater addition to his powers than the rule-of-thought processes known as the scientific method. His senses registered in his inner consciousness many and conflicting impressions of matters existing outside of himself. To be able to sit down, so to speak, within the darkness of his own mind and soul, and quietly sift out those impressions to which he wished to give his attention, and then to devise ways of extending the usefulness of his sensory powers, so that he could increase the scope of his knowledge, in the line of his interest—that was to achieve the scientific method. This method of thought is not often innate, nor is it transmissible by inheritance. It must be transmitted by training and developed by practice.

When chemistry and science in general were young each new disciple repeated the experiments and observations and retraced the thought processes of the master. In this way he learned the scientific method unconsciously, by imitation, just as children learn to speak. Any latent gifts for orderly investigation were thus slowly matured to fruition. This is no longer the practice in most elementary instruction in chemistry. The existing facts and theories are considered to be more important than the acquisition of the method by which they were achieved. There is so much to be done and so little time for doing it.

Probably the first teachers who gave up this older method of instruction could by conversation with their pupils, in which they dwelt in loving memory on the intellectual traits and thought processes of their masters, convey much of this fine personal touch and communicate in this way much of what was lacking on the formal side of their courses. But these pupils, when they in turn became masters, could reflect only a highly diluted tradition. In this way a very fine cultural quality of chemistry is rapidly

being lost. Teachers can no longer sit down with a pupil and teach him how to think by thinking with him. They must quickly tell him what to think, or at best use a reverse process and knowing the answer lead the pupil to seize upon it. Only in some types of graduate work does the teacher sit down and think with his pupil. The chief objection to this method is that it is applied too late and, moreover, the training is available for only a very small number of individuals.

What is wanted is a type of training of this sort that is available for large numbers of pupils at an early stage in their mental maturation. Something is wanted in which it is possible for the pupil to test and retest in his own way and to his own satisfaction the utility and logic of the method that he is being taught. Something in which his teacher, if he wishes, can dissociate himself temporarily from his position of superiority and approach the problem in the same spirit as the pupil. The material should be well within the scope of the powers of the pupil so that he need not rely too much upon authority. If he entertains doubts as to the correctness of the viewpoint presented or of the alleged facts offered him it should be possible for him to test his own questionings and his own young ideas. For such purposes as these in training in the scientific method, it is the writer's opinion that qualitative analysis offers advantages over all other subjects in the curriculum, other things being equal. In qualitative analysis it is possible to give training in patience, in orderly procedure in carrying out a preconceived plan, in objective observation, in close attention to details, in the sifting and sorting of significant from insignificant facts, in piling up and weighing evidence, in applying and devising crucial tests to verify partially drawn conclusions, in solving a problem by intuition and then laboring to test the correctness of the intuitive solution. The student may be led to approach the analysis of an unknown as though he were determining the identity of the substance for the first time. In this way he may have the interest and excitement of an explorer. He has many things to consider and many decisions to make because he is facing a many-sided problem. If he can learn to steer a logical and clear-headed course in his analysis of a difficult unknown he probably has a better idea of what scientific thought is than he ever had before. If he makes a mistake he can retrace his steps one by one and discover his error. If he cannot do this alone a conference with his instructor will enable him to do it. Very often the instructor can remain in ignorance of the nature of the unknown in question and can approach the discussion of the difficulties in true sympathy with his pupil. The two now find themselves in a situation in which the greater mental and manual skill of the instructor is appreciated. The situation is ideal for transmitting the technic of thinking and the value of true proficiency.

Conceived in this way qualitative analysis not only gives those pupils

who expect to continue in the study of chemistry an opportunity to learn the basic principles of analytical chemistry, but it gives all who study this subject properly intensive training in orderly thinking. Probably no people have ever known so much and thought so little as the rank and file of the American people. We are readily swayed by all sorts of fads and propagandas. Our reactions to a novel problem or situation are often worse than infantile because we have lost our childish curiosity and interest. When confronted by a complicated question we have little trained capacity for analyzing the problem for its possible elements, for devising methods for obtaining suitable data, and for sifting the significant from the insignificant facts. The education that should supply us with this capacity often merely benumbs our innate powers. Our ancestors learned much of value in this respect in the University of Hard Knocks, but modern conditions have led to the postponement of matriculation in this fruitful institution and the involuntary entrants receive less benefit from it than formerly.

It is often stated that mathematics is the ideal vehicle for teaching the scientific method. Such a statement loses sight of the fact that training in this method involves manual as well as mental discipline. In the usual method of teaching mathematics "tailor-made" data are supplied by the text-book and we all have had experience in attempting to revitalize such "dead" problems. Something of the type of proficiency involved here may be indicated by an illustration. An artisan may be asked how he is going to repair or build something and will reply that he does not know just how it can be done. But when he takes up his tools his mind works with his hands and the task is quickly and expertly finished. His thinking was largely unconscious and its value was determined entirely by the proficiency with which his hands translated it into action. The value of his work was not determined by what he thought, but by what his thoughts became when realized by his hands. It is for this reason that all manual training is so important in the education of the engineer. It enables him to visualize the manual operations involved in gathering the data that he requires and in executing the designs that he develops, when it is no longer possible for him to do these things with his own hands. This close connection between abstract thought and concrete action is worthy of a great deal of close thought and consideration. So much of our education is a passive process. Our pupils sit on a bench and read out of a book, or listen to much talking instead of thinking and acting. Consequently, they find difficulty in connecting their education with their lives. When we wish to learn to play a piano, or to play tennis or bridge, or to cook or to lay brick or to plant corn, we serve an apprenticeship, in which we learn to think and act like our teacher, in order to achieve a certain mental and manual proficiency in the new art. The effective mastery of the scientific

method is much more difficult than any of these arts, and yet it is not often taught so carefully or so well.

It was not the writer's purpose in preparing this little paper to describe in detail how resourceful mental and manual proficiency in the pursuit of a given problem, in life in general, or even in qualitative analysis, is to be achieved. It was merely desired to point out that this proficiency is dual in nature and that of all subjects in the elementary curriculum qualitative analysis may best be presented in such a way as to give broad training in resourceful thinking. It is clearly implied that any capacity for using the scientific method, that may be acquired, will be useful in any situation in which orderly thought is required.

New Science Head Will Promote Popularization. The popularizing of science was urged by Dr. A. A. Noyes, recently elected president of the American Association for the Advancement of Science, in a statement made at the request of *Science Service*. Dr. Noyes said:

"It seems to me that there are three main directions in which the American Association for the Advancement of Science is making large practical contributions to the 'Advancement of Science'—the purpose expressed in its title:

"It is popularizing science by creating better appreciation among the intelligent public of the spirit and methods of science and of the tremendous intellectual and practical importance of extending, by research, the bounds of knowledge.

"It is acting as an agency for the federation and broadening of scientific work, by bringing together, especially at its annual meetings, the various scientific societies and leading scientific men in different fields.

"It is directly promoting research by the formulation and promotion of large projects of investigation, by assistance to and recognition of individual investigators.

"The last of these functions the Association shares with other scientific organizations. In connection with the first two of these functions it has, however, a somewhat unique opportunity; and to fuller realization of this its efforts in the next few years should, I think, be primarily devoted."

Dr. A. A. Noyes is director of the Gates Chemical Laboratory at the California Institute of Technology, Pasadena, a position which he has held since 1920. Previous to that time he had for seven years been in charge of research in chemistry at the same institution. His earlier career had centered at the Massachusetts Institute of Technology, his first alma mater, and had included a period of two years as its acting president.

Dr. Noyes was born at Newburyport, Mass., in 1866. His education began at the Massachusetts Institute of Technology, where he received his bachelor's degree in 1886 and his master's degree one year later. He went to Germany for his Ph.D., which he received at Leipzig in 1890. He holds honorary degrees from the University of Maine, Clarke University, the University of Pittsburgh, Harvard University, and Yale University.

Dr. Noyes represents the National Academy of Sciences upon the board of trustees of *Science Service*. He is an honorary fellow of the Royal Society of Edinburgh and a member of the National Academy of Sciences, the American Philosophical Society, and the American Academy of Arts and Sciences. He was president of the American Chemical Society in 1904, and in 1915 received from that body the highest honor in its gift, the award of the Willard Gibbs medal.—*Science Service*

SOME FUNDAMENTALS OF LABORATORY INSTRUCTION*

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If a school has a splendidly equipped laboratory, the patrons of it are apt to think that chemistry is well taught there. The good equipment is not necessarily a handicap but it can so fill the mind of a teacher that "the things that are more excellent" are unnoted. Two general faults may be commonly observed in the teaching of chemistry in secondary schools, one of the teacher and the other of the pupil.

The topics of chemistry are generally presented to the pupil *first* through the medium of a text-book, then laboratory exercises follow. Consequently the pupils know most of the results of the experimental work before it is performed, so they find little need of the data of the experiment. They do not object to this useless work because it *is* entertaining to mix chemicals, but the experiment is performed and written up in a mechanical way.

In this way the pupils get little mental training, particularly in the great value of the experimental method as the best method of finding the truth. They depend on what others say and develop little ability to know for themselves. The text-book approach was discontinued long ago at Lake View High School, Chicago, when a pupil furnished the eye-opener of writing his experimental record according to the statements of the text-book and ignoring the contradictory results of the materials before him. We suspect that the attractiveness of this method is to be found in the more correct record that the pupil writes. The real purpose of any experiment in *training the mind to learn* seems to be neglected.

Most of the young people in high school and college will avoid using their own minds if they can, and in all too many cases they are permitted to do so. Yet they are being graduated from these institutions. Without close supervision the *individual* laboratory work is only another way of evading an education. Our data of several years' study show that about 10 per cent of the third- and fourth-year pupils can engage profitably in individual laboratory practice. All the others require training in how to study by the laboratory method, and they must be kept under close supervision if it is accomplished. To scatter pupils at individual tables prevents this. What these pupils need most is how to think and learn. The teacher can do this most effectively and at the same time most economically by keeping them grouped closely together near one table where one or two pupils perform the experiment, while the others *observe the results, think out the interpretation, and write a record of it.* The teacher, unhampered by doing demonstration work, gives his whole time to *guiding*,

* Read before the Division of Chemical Education of the A. C. S. at Philadelphia, Pa., Sept. 10, 1926.

questioning, and really instructing the group. The whole group can be shown, at the same time, how to interpret data and learn as they must learn later in life affairs. When a laboratory period conducted by this method ends, every one of the group has all of the points to be learned and has them correctly. The records are written and complete, and the teacher knows that they are correct. The method is certain in its results. As soon as each pupil shows proficiency, he may be intrusted with individual work and, at times when individual contact with materials is desired, the whole class may work separately with the thorough understanding that the work will be performed in the spirit that has been taught to the group.

The text-book being found unsatisfactory as an introduction to laboratory practice, it is necessary to supply something else to give the pupil a fair knowledge of the laboratory problems. This can be done splendidly in an oral fashion by the teacher in the group method. If an introduction in printed form can be supplied, it can be studied by the pupils in outside time and conserve the needed time of the laboratory period.

Another point in the improvement of laboratory instruction is to be found in the emphasis of chemical principles rather than mechanical detail. The early teaching of chemistry was chiefly concerned with the technics of the subject. Few contacts were made with life situations. As time went on the text-books began to grow in size, chiefly with the inclusion of applications of topics to life, a larger consideration of the chemistry of commerce and industry, and finally with the practical aspects of chemistry in the home and daily life in general. This growth toward the practical side of chemistry has wonderfully enriched the subject, yet all that has been done is only a beginning of the possibilities that are opening up before us.

Experiments devised to exemplify chemical principles frequently make no contacts with the experience of the pupils and as such are not sufficiently impressed on the pupils' consciousness. To remedy the situation the teacher turns to the chemical side of the work of the home, the shop, and the market place to provide an incentive for the pupil. It is easy to secure the interest of the pupil in this way even if the work has no value. Sometimes we fall into a worse situation in that *the chemical work undertaken has little or no contact with chemical principles.* In avoiding Scylla we fall into Charybdis.

The topic, baking powder, is selected to illustrate the point, since it has contact with the lives of everyone. Most of the laboratory manuals in use take up this topic by having pupils make various chemical tests for the probable ingredients of baking powder. These objections are offered.

1. The function of each ingredient of the baking powder and the nature of the chemical action are usually presented in the text-book pre-

vious to the experimental work so there is nothing vital left for the laboratory study.

2. The experimental work consists of qualitative tests for the components, mere technics that are of value only when their use reveals information of value. Resort to analysis is unnecessary here for the information may be more quickly and certainly learned from the label on the package. Further, the pupils are inexperienced in analysis and every class using this experiment will have some pupils reporting the absence of a component whose presence is declared on the label by the manufacturer. In summarizing the criticism it may be said that the purpose of the experiment is unnecessary and the method of executing it is inefficient.

The following procedure is offered as an example of a more worthy method.

Bread

Introduction.—For fifty centuries the world stood still—waiting to be fed. The great masses of population, men, women, and children, toiled through the long days to obtain a bare subsistence of food and a hovel for a home. When there was bread enough to satisfy hunger, that day was called a feast day for there were many days of fasting. In this age of the achievements of science we ask "What shall we have for dinner today?" and proceed to gratify our appetites with whatever pleases the palate, even if it does not accord with the laws of nutrition.

The one great cause of this transformation of conditions is labor-saving machinery. The steel-faced plow which uproots the prairie sod, the cultivator by which one man can destroy the weeds on ten acres of ground in a day, and the harvester and thresher which rapidly reap the harvest and give back to modern man the golden wheat by many hundred-fold. With modern machines one man now produces as much food as the labor of hundreds in primitive times. But the metal to make the machinery must first be won from Nature through the science of chemistry. The initial or fundamental work of all material progress is performed by the chemist. His work makes possible the steel plow to supplant the sharpened stick, the steel hoe for the clam shell, the binder for the sickle, the thresher for the flail, the roller mill for the pounding stone, and finally the leavening baking powder to transform the wheat flour into light bread in a few minutes. This multiplication of the productive power of man makes the cereal grains abundant and, therefore, cheap. The same cause operates to lessen the cost of the essentials of life. No longer does each one work arduously from sun to sun for food and the necessities of life. There is leisure time for recreation and the cultivation of the finer arts.

Baking powder was invented as a means of leavening bread quicker and more economically than with yeast. The various kinds differ mainly in the use of a different substance as the acid principle. In this manner three different classes of powders are known.

1. *Cream of Tartar.* This class contains potassium bitartrate and sometimes tartaric acid as well. The cost of this ingredient makes this powder the most expensive. It is changed to Rochelle salt, a drug, in the process of bread making.

2. *Phosphate.* An acid phosphate, usually calcium superphosphate, is used. It is cheaper than the bitartrate and while the sodium and calcium phosphates formed in the bread are drugs, there is possibility of them being used in the body as mineral foods.

3. *Alum.* Some one of the alums, generally sodium alum, is used. It is very cheap and slow acting, but has no advantage otherwise over the other kinds. The aluminum hydroxide and the salts formed have no possible values as foods. Many persons object to the use of aluminum compounds in foods.

Yeast leaves no undesirable residues in the bread so it is greatly preferred for leavening purposes. About 2 per cent of the carbohydrates are decomposed by the diastase and zymase in the leavening process.

Starch readily takes up moisture so it is always put in baking powders to protect the mixture from action when exposed to the moisture in the air. Some manufacturers appreciate this fact so much that they put in a very liberal supply. In such cases the starch becomes a filler to cheapen the powder.

Experiment on Baking Powder

Purpose: To study the chemical reactions of the principal ingredients of baking powder.

I. *The Leavening Agent.* Put a large pinch of sodium bicarbonate in a clean test-tube, dissolve it with a little water, and test the solution with red litmus paper (?). Put a few drops of sulfuric acid in the solution, note the effect, and test the gas in the tube by a drop of lime water on the end of a stirring rod (?).

Questions. 1. Solutions of acid salts usually contain the hydrogen ion. What ion is shown by the litmus test?

2. Explain its presence by enlarging this statement: Hydrolysis takes place to a greater degree than the ionization of the acid salt.

3. Write the equation of acid reacting with the sodium bicarbonate.

II. *The Acid Principle.* In separate watch glasses or beakers put a large pinch of potassium bitartrate, monocalcium phosphate, and any one of the alums such as sodium aluminum sulfate. Press a piece of blue litmus down on each substance while dry. Examine for effect (?). Put a little water on each of the substances (?). Tabulate the dry and wet litmus tests.

4. Why do dry substances (molecules) not affect litmus?

5. What ion is shown to be present in each case?

6. Explain its formation in each case. (The first two substances are acid salts. Hydrolysis takes place in the solution of the last.)

Complete these equations:

$NaHCO_3 + KHC_4H_4O_6 \longrightarrow KNaC_4H_4O_6 + ? + ?$

$NaHCO_3 + CaH_4(PO_4)_2 \longrightarrow CaHPO_4 + Na_2HPO_4 + ? + ?$

$NaHCO_3 + Na_2SO_4.Al_2(SO_4)_3 \longrightarrow Al(OH)_3 \div Na_2SO_4 + ? + ?$

7. Why do all baking powders contain sodium bicarbonate?

8. Why must all baking powders contain a substance of acid nature?

9. Why does exposure to air for a time make baking powder less effective?

10. Why is starch an ingredient of all baking powders?

11. Which baking powder leaves the least objectionable residues in the bread?

12. Why is yeast a better means of leavening bread than baking powder?

III. *Comparison of Baking Powders.* Obtain several different types of baking powders. Fill a dry cartridge shell with each, quickly insert them under separate test-tubes filled with and inverted over hot water (?). Compare the different powders in a tabular form regarding components, speed of action, and available carbon dioxide. See the label on the can for the components.

13. What powders are rapid in their chemical action?

14. Why should dough containing such powders be put into the oven quickly after mixing?

15. Should the oven be slow or fast in baking bread containing a rapid baking powder? Why?

The points of value of such a procedure are that:

(1) A specially prepared introduction opens up the topic to the pupil's mind and at the same time the service side of chemistry is emphasized as it operates in life situations. Information *not obtainable by laboratory study* is herein provided so that the pupil may begin to synthesize the knowledge of the topic.

(2) In the experimental work the properties of the two main ingredients of baking powder are studied with the manner of their interaction to produce carbon dioxide.

(3) Fundamentals are stressed by specific questions requiring the pupil to consider the experimental data and learn from these facts.

(4) Three types of baking powder are compared as to cost, rate of action, and wholesomeness.

(5) Leavening with baking powder is compared with leavening with yeast.

(6) The chemical principles of neutralization, ionization, and hydrolysis are applied and illustrated.

(7) Parts I, II, and III are fundamental and required of all pupils. Additional parts are provided for the more proficient pupils so that they need not be kept at the same level as the slower ones.

(8) A summary with exercises for drill on fundamentals is provided as a review for a following day. Here again advanced work is provided for the more apt pupils.

(9) Practical points in the use of baking powders are developed with study of the chemical principles so that the pupils cannot fail to apply these principles in life situations.

(10) Instead of practice with technics of little value the pupils are trained to think from facts, learn chemical principles, and to apply them in daily life.

New Outdoor School in New York Wilds. Natural history taught in natural surroundings is the central idea of a new summer school which will be opened this season in Allegheny State Park, about 75 miles south of Buffalo. Courses in geology, geography, and physiography will be offered, in addition to work on the plants and animals of the region. The school, which will have accommodations for 50 pupils, will operate under the direction of Chauncey J. Hamlin, president of the Buffalo Society of Natural Sciences and Dr. Charles C. Adams, director of the New York State Museum.—*Science Service*

A PSYCHOLOGICAL BASIS FOR OBJECTIVES*

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There have appeared in THIS JOURNAL several excellent discussions of the objectives of high-school chemistry. The writer feels that he may add to the merit of these formulations of objectives by submitting a basis for their classification which is founded on educational psychology.

"It should be obvious that it is the teacher's immediate purpose to engender in his students certain abilities. However, such a designation of objectives would be of doubtful value without a clear understanding of the term 'ability.' Psychologically 'ability' refers to the bonds connecting situations and responses, and the acquiring of abilities is the forming of bonds between situations and responses, so that whenever a given situation functions as a stimulus a certain response will tend to follow."[1] In that the response may be considered as behavior or conduct, it will be seen that ability, in as much as it modifies response, may be thought of as a control of conduct. It may also be shown that ability, or control of conduct, has certain characteristics which are determined by the nature of the situation. When the situation has been encountered often enough that the ability acquired is of the nature of a specific habit, we may designate that ability as a "fixed control of conduct."

When the situation contains certain new elements and demands a response which has never been made by the individual, and will require reflective thinking, we may designate this type of ability as an "adaptive control of conduct." These adaptive controls may be thought of as knowledge with the ability to use it.

There are ways in which an individual responds to many types of situations which are determined by a type of ability known as a general pattern of conduct. If one has the ability to feel satisfied when work is done neatly, or annoyed when it is not, then one has acquired such a generalized control. This pattern of conduct, in other words, is the "ideal" of neatness. Such patterns of conduct may accompany the other controls mentioned previously and modify the response to any given situation.[2] The definition of the immediate objectives of high-school chemistry as abilities, and their interpretation as controls of conduct, offers a most satisfactory basis for the study of objectives. It would perhaps be well to give at this point an outline of the classification of objectives to be used in this article.

* Part of thesis for degree of Master of Science in Education, University of Illinois, June, 1926.

[1] Walter S. Monroe, "Teacher's Objectives," a paper read at Superintendents' Conference, University of Illinois, November 19, 1925.

[2] E. L. Thorndike, "Educational Psychology," Teachers' College, Columbia University, New York, 1921, Vol. 2, p. 25.

I. Fixed controls of conduct
   (*a*) Motor skills
   (*b*) Fixed associations

II. Knowledge or adaptive controls of conduct
   (*a*) Content of knowledge
      1. Concrete ideas
      2. Abstract and general meanings
      3. Theories, principles, and hypotheses
   (*b*) Use of knowledge
      1. Reflective thinking
         (*a*) Chemical phenomena
         (*b*) Problem solving

III. Patterns of conduct, or generalized controls
   (*a*) Ideals
   (*b*) Attitudes
   (*c*) Interests

The immediate objectives of high-school chemistry, designated as "fixed controls of conduct," are divided into motor skills and fixed associations. Motor skills and fixed associations are alike in that they demand an unvarying response to a given stimulus and, as such, are specific habits. The differentiation is made necessary because of the dissimilarity of the manner in which these abilities are performed. For our purposes, a motor skill implies a type of ability which demands the use of certain parts of the body, notably the hands, in close coördination with the brain. The engendering of motor skills may be one of the functions of the laboratory work. The nature of the abilities designated as fixed associations is shown by the manner in which a student responds to such a question as, "What is the formula of water?" The student bases his response on memory or, more precisely, his previous experience with the same situation. The response should be immediate and unvarying.

The writer wishes to submit below a few examples of motor skills and of fixed associations which might be classed among the immediate objectives of high-school chemistry. No attempt will be made here to give a complete formulation of objectives, it being the purpose of this article to merely suggest a classification which might be used.

Motor Skills

1. The ability to cut and break glass tubing into lengths desired.
2. The ability to fire polish glass tubing.
3. The ability to insert glass tubing into the holes in cork and rubber stoppers.

4. The ability to bore holes in cork and rubber stoppers.
5. The ability to adjust the Bunsen flame.

Fixed Associations

1. The abilities necessary to give the symbols of the common elements.
2. The abilities necessary to give the names of the common elements when presented with their symbols.
3. The abilities necessary to give the formulas of common compounds.
4. The abilities necessary to give the valence of the more important elements.
5. The abilities necessary to state certain important laws, theories, and hypotheses.

In considering the second rubric of the immediate objectives of high-school chemistry, adaptive controls of conduct, it is necessary to specify the materials which make such controls possible. Such materials may be designated as knowledge and arbitrarily divided into the following classes:

(*a*) Concrete ideas—or perceptual meanings.
(*b*) Abstract and general meanings—or concepts.
(*c*) Theories, principles, and hypotheses.

The first of these classes may be illustrated by examples from the laboratory work. The student's ideas of boiling, precipitation, colors and odors of substances, and the like are the result of perception. The formation of such ideas results in many cases in fixed associations.

The second of these classes, abstract and general meanings, may be the result of the integration of the concrete ideas, and the result of the scientific use of the imagination. For example, the general meaning given to the word "sulfur" will be the result of the sum total of many associations related to that element, and certain ideas of things unseen which are the result of imagination. Such a general meaning, or concept, might be made up of the following ideas:

1. The symbol for sulfur is "S."
2. The atomic weight of sulfur is 32.
3. It is a constituent of such acids as H_2S, H_2SO_3, and H_2SO_4.
4. Sulfur is found free in nature.
5. The allotropic forms of sulfur are due to the different numbers of atoms in the sulfur molecule.
6. The valence of sulfur is due to the number of electrons in the outer shell of the sulfur atom.

It will be seen that the ideas as to the atomic structure of sulfur may not

be presented to the student as perceptual experiences. His ideas of such structure are due to the use of his imagination.

The third class, theories, principles, and hypotheses, is the result of inductive reasoning as applied to concrete ideas and abstract and general meanings. This may be illustrated by the method in which a student acquires his knowledge of the principle, or law of mass action. (Note: this is not merely the ability to state the principle from memory.) The student learns that the reaction, $AgNO_3 + NaCl \longrightarrow \underline{AgCl} + NaNO_3$, goes to completion because silver chloride is precipitated. He learns that $2AgNO_3 + Na_2SO_4 \longrightarrow Ag_2SO_4 + 2NaNO_3$, does not go to completion because no insoluble precipitate is formed. Other reactions of a similar character are observed. Then the student learns that the reaction $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl\uparrow$, also goes to completion. By the process of inductive reasoning the student comes to the conclusion that when a product is removed from the solution either as an insoluble precipitate, or as a gas, such a reaction will tend to go to completion. By deduction, the student should be able to apply this principle to reactions which are new to him. His knowledge of this principle will be much more complete as a result of the above process than if he had merely memorized a statement of the principle.

The above discussion indicates to some extent what is meant by the content of knowledge which might constitute some of the immediate objectives of high-school chemistry. A source of what shall make up this content of knowledge is to be found in the "Standard Minimum Course" of the Division of Chemical Education.

The next topic of our classification of immediate objectives, as given in the outline, is the use of knowledge in reflective thinking. One of the claims most frequently made for chemistry instruction is that it engenders in the student the ability to do reflective thinking. Without question the attainment of such an ability is desirable, and should constitute a worthy objective. There is, however, a certain danger stated by Dewey[3] which should be avoided. "In the case of the so-called disciplinary or preëminently logical studies, there is danger of the isolation of the intellectual activity from the ordinary affairs of life. The danger in those studies where the main emphasis is upon the acquisition of skill is just the reverse. The tendency is to take the shortest cuts possible to gain the required end. This makes the subject mechanical and thus restrictive of intellectual power." High-school chemistry may be taught in such a way that the intellectual activity is isolated from the ordinary affairs of life. It may also be taught so that the acquisition of skill predominates. In other words, a course in which the motor skills and fixed associations are over-emphasized. It is the viewpoint of the writer that these dangers

[3] John Dewey, "How We Think," Heath and Company, New York, 1910, p. 51.

are to be avoided by utilizing the fixed controls in engendering the adaptive controls, and by introducing topics after having created the proper mental set by referring to past experiences of the student's every-day life, and further, to develop topics in such a way that useful applications are given.

In discussing the application of knowledge in reflective thinking as utilized in meeting new and perplexing situations presented by chemical phenomena, it is helpful to divide the process into five more or less distinct steps. Cameron's statement of these steps is given below:[4]

1. A perplexing situation which causes a feeling of difficulty.
2. Noting clearly the source and nature of the difficulty.
3. Forming various ideas which may possibly solve the difficulty.
4. Considering what the results would be if these various ideas were accepted.
5. Further observation and (sometimes) experiment leading to acceptance of one of the ideas with the rejection of others.

An example might be given to show how a student in the course of his proper performance of a laboratory experiment, undergoes such a process of thinking in arriving at his results. However, to be successful in the inculcation of knowledge such a process should be largely "internal." It could also be shown how the above process may be carried over into the class-room, where the particular phenomena observed in the laboratory could be used to illustrate a general principle and to show certain useful applications. The above five steps are also useful in describing the correct manner of solving chemical problems.

The third and last rubric of our classification of immediate objectives is that of patterns of conduct, or generalized controls. The nature of such controls has already been discussed. Such a generalized control is most easily understood in terms of the satisfaction or dissatisfaction felt by an individual in responding to any given situation. In other words, the emotional side must be taken into account. In the case of the motor skills, the individual may perform a specific activity neatly, with little conscious realization that neatness in itself is desirable. On the other hand, if the individual has the ability to feel annoyed if the activity is not performed neatly, and satisfied if it is, he has acquired the general pattern of conduct of neatness. This individual is more likely to appreciate the value of neatness in other activities. If the training received in one course of study is to carry over into others the value of forming such patterns of conduct is apparent. Many objectives given by several writers in this field, may be classed as general patterns of conduct. For example, such statements as "moral attitudes," "intellectual honesty," "truth," "the value of self-elimination," "interests in science," and "the appre-

[4] E. H. Cameron, "Psychology and the School," The Century Co., New York, 1922, p. 143.

ciation of the significance of science" may be classed as general patterns of conduct when listing them as objectives of high-school chemistry.

In closing it might be said that such a classification of objectives will be found most useful in determining not only the justification of our setting such objectives, but in determining what methods are most sound, according to educational psychology, for the purpose of engendering such objectives.

New Mosquito Poison Developed in France. E. Roubaud, of the Pasteur Institute in Paris, has recently announced that a formaldehyde compound manufactured in France offers advantages over anything previously used in the fight against mosquitoes.

M. Roubaud is a man of such high scientific standing that U. S. government entomologists are going to make tests, it is announced at the Bureau of Entomology. The new compound may prove to be a weapon in the hands of Americans who are handling the question of mosquito control over very large salt marsh areas. Even if this should prove impractical it appears that the new substance will be available for easy treatment of small ponds, fountains, and the like.

The preparation is said to be non-poisonous to warm-blooded animals and fish and to have no injurious effect upon aquatic plants. It is in the form of an extremely light dust, readily driven by the wind. Settling upon the surface of the water, it brings about the almost immediate death of the larvae of the malarial mosquitoes, which are top feeders, and with a subsequent slight agitation of the water sinks slowly in suspension where it is eaten by the larvae of other mosquitoes.

Roubaud recommends a mixture by weight of one part of the powder with fifty parts of very dry sand. This mixture has been tried successfully by him on fields in Alsace inundated by the Rhine. The cost of this method of treatment compares favorably with the arsenical dusts used in this country. It is said to amount to fifty francs to ten hectares of water surface, or about eight cents an acre at the present exchange rate.—*Science Service*

Ultra-Violet Irradiation of Mothers Prevents Rickets in Babies. If a baby develops rickets in spite of receiving his nourishment in the way traditionally supposed to be best for babies, the anxious parents should not immediately put their young hopeful on a bottle. He can quite possibly be cured by having his mother treated with ultra-violet irradiations.

Although the great advantages of mother's milk are not questioned, Dr. Alfred A. Hess of the Columbia University College of Physicians and Surgeons, has reported to the American Medical Association that from one-third to one-half of the breast-fed babies met with in his experience in this climate have rickets. Working in collaboration with Mildred Weinstock and Elizabeth Sherman, Dr. Hess has conducted experiments that show that the antirachitic substances in human milk are greatly increased by irradiation of nursing mothers with ultra-violet rays. Though direct sunlight has been of great benefit in treating rickets, in this connection it has been found not to give as positive results as the quartz mercury vapor lamp, said Dr. Hess.

These experiments, he continued, suggest that irradiation of the mother while she nurses her baby will not only protect the baby from rickets but will help keep up her own nutritional status. This is especially important because the excessive drain on the calcium and phosphorous content of the body often results in serious impairment of the teeth in young mothers. How effective and practical the method will be, must be determined by further clinical experience, Dr. Hess stated. —*Science Service*

COMPUTATIONS IN GENERAL CHEMISTRY*

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To the average student in general chemistry, problems frequently eliminate all of the interest a conscientious teacher may succeed in imparting. All else may be going well when failure to work problems correctly creates the entering wedge of discouragement. When the situation is analyzed, it is found that a student can usually handle a problem in pure mathematics, arithmetic, simple proportion and algebra quite readily. He has been drilled mostly along this line and acquires a formula procedure and the haste to obtain results. Little effort is spent in reasoning or checking in problem work.

Naturally, early in the course, the student has to do with oxygen and hydrogen and gas laws. He will memorize formulas such as $P'T = PT'$ and substitute numbers, very often in an uncertain manner. If he is dealing with temperature changes, a temperature being given in Fahrenheit degrees, he tries to recall a formula, and, if he uses the formula only occasionally, it is not readily available or involves doubt. Having been taught what Fahrenheit, Centigrade, and absolute temperatures are and how temperatures on one scale are converted into the others on a pure reasoning basis, proceeding from fact to formula, but not being expected to memorize formulas, and with sufficient application, the student has the procedure fixed in his mind for a relatively long time. How shall we develop this topic? Only by making clear to the student that water freezes at 32°F., 0°C., and 273° absolute and that it boils at 212°F., 100°C., and 373° absolute, and, that, while the freezing temperature of water on the Fahrenheit scale is represented by 32 numerical units, on the Centigrade scale it is 0. Also that there are 180 numerical units on the F. scale representing the same range or degree of temperature as 100 units on the C. scale. With the common blackboard illustrations and a few computations followed by a little oral and written class work the student readily and accurately works out temperature conversions and the formulas. He now sees the necessity of obtaining the same zero point and of expressing the same degree of temperature by the number ratio, 180:100 or 18:10 or 9:5 for the two common scales. Thus to convert 65°F.

	F.	C.	abs.
B. p. of water	212	100	373
F. p. water	32	0	273

to C. temperature he first subtracts 32 numerical units to bring the temperature to the same zero basis and multiplies by $^5/_9$. To convert 20°C.

* Read before the Division of Chemical Education of the A. C. S. at Philadelphia, Pa., Sept. 7, 1926.

to F. temperature, he multiplies by $^9/_5$ and adds 32. The conversion formulas then must be C. $= {}^5/_9$ (F. $- 32$) and F. $= {}^9/_5$C. $+ 32$. Students have little difficulty in converting Centigrade temperatures to absolute and the reverse.

The next step in problem work should then be the learning of the qualitative and quantitative facts expressed by the laws of Boyle and of Charles (Gay-Lussac on gas volume temperature changes). He must also learn that water vapor exerts a pressure which must be considered whereas the vapor pressure of mercury is negligible. With the factors involved taken up step by step and problems used for illustration, the idea will soon become fixed that a gas volume conversion is either a four- or six-factor proposition with a pressure correction if the gas is measured over water. Aside from their deduction, no further attention is given to formulas. As an illustration, 50 cc. hydrogen over mercury at 740 mm. would yield what volume under standard pressure? (By this time in the course students should have learned thoroughly that standard temperature for gases is 0°C. and standard pressure is 760 mm., also that gases exist as molecules and that molecules of hydrogen are expressed as H_2 and of oxygen as O_2.) This is, therefore, a four-factor proposition, three factors are known (measured volume, measured pressure, standard pressure). Then

50 cc. H_2 at 740 mm. (over mercury)
X cc. at 760 mm.

$$X = 50 \text{ cc. } H_2 \times \frac{*740}{760}$$

* Hesitation and consideration, that, qualitatively, the volume of a gas varies inversely as the pressure or that if the pressure is increased the volume must be less. The numerator must, therefore, be the smaller pressure. By inspection, the answer must be under 50 cc. H_2. Using arithmetic, logarithms, or slide rule, or by using two of these methods of computation the volume of hydrogen under the new condition of pressure can be quickly and accurately determined. Using the symbols V and P for the initial volume and pressure and V' and P' for the final or new volume and pressure, and substituting, it becomes evident to the student that $V' = V \times P/P'$ or that $V'P' = VP$.

Having worked a few problems of this type, the next step would be the changes of volume with temperature, the law of Charles being stated as follows: The volume of a gas varies directly as the absolute temperature. (The student by this time thoroughly understands that 0°C. $= 273$ abs., 100°C. $= 373$ abs., -20°C. $= 253$ abs., that 273 cc. H_2 at 0°C. or 273° abs. become 274 cc. at 1°C. or 274° abs. or that 280 cc. O_2 at 7°C. (280° abs.) shrink in volume to 273 cc. at 0°C. (273° abs.); in other words that gases increase $^1/_{273}$ of their volume at 0°C. for each degree rise in temperature abs., etc.) Using a problem for illustration: What is the volume of 20

cc. O_2 at 19°C. under standard conditions, to tenths? Here again we have a four-factor proposition, three factors being known to solve for the fourth. Thus:

20 cc. O_2 at 19° C.
X cc. at 0° C.

Changing to absolute temperature,

20 cc. O_2 at 292 abs.
X cc. at 273 abs.
X = 20 cc. O_2 × †273/293

† Hesitation; under the new conditions the temperature is less, therefore the volume must be less and the numerator must be the smaller absolute temperature. By inspection the answer must be between 15 and 20 cc. O_2. The student then deduces the formula using T as the original, old, or measured temperature absolute, and T' as the new absolute temperature as follows: $V' = V \times T'/T$ or $V'T = VT'$. The student then works three or four problems of this type.

The next step is the solution of problems involving gas volume changes due to temperature and pressure changes simultaneously. Here we deal with a six-factor proposition, five factors being known, to solve for the sixth. Example: Compute the volume 40 cc. H_2 would occupy if the temperature is changed from 18°C. to standard temperature and the pressure from 770 mm. to standard, the gas being measured over mercury, to tenths.

(291°abs.)
40 cc. H_2 at 18°C. and 770 mm.
X cc. at 0°C. and 760 mm.
(273° abs.)
X = 40 cc. H_2 × ‡273/291 × §770/760

‡ Hesitation and thought; under the new conditions the temperature is less, therefore the volume must be less and the numerator must be the smaller temperature.

§ Under the new conditions, the pressure is less, therefore the volume must be greater and the numerator must be the larger pressure. By inspection, the answer must be between 30 and 40 cc. H_2 and the computation can be easily worked using logarithms. (The writer has observed that students without previous training in logarithms can quickly learn the essentials and apply them to weekly problems with a great saving of time.) For blackboard work, a four-place logarithm table on a card is kept available. (The Central Scientific Co. publishes such tables.) The formula is then deduced as $V' = V \times T'/T \times P/P'$. After three or four problems of this type the student works a few problems involving the correction of pressure when gases are measured over water. The student thus soon learns to work all kinds of gas volume changes quickly and accurately, when these are due to temperature and pressure.

The mass of material in our general chemistry texts, the relatively small allotment of time for the task, and the multiplicity of extra-curricular activities make it necessary to eliminate the memorization of formulas including

such as $v_0 = pv/p_0(+0.003665\,t)$. They are not necessary and are not used frequently enough. Thus their place appears, to the writer, to be in advanced and specialized texts.

Mass Unit Weights

Before the student can understand atomic weights, it is necessary for him to have a thorough understanding of combining weights. Frequently one finds combining weight terms used in texts without sufficient explanation. Only when combining weights are stated with the clause "to oxygen = 16," "to oxygen = 8," "to hydrogen = 1" do they have adequate and definite meaning to the average student. The writer uses only the expression "to oxygen = 16" and disregards the historical development for general chemistry students. One laboratory period devoted to combining weight determinations, even with the use of triple beam, agate bearing laboratory scales, is very helpful in teaching combining and atomic weights.

Although many chemistry teachers would readily drop multiple proportion from a course in general chemistry, because of its difficulty, the writer feels that it is a very fundamental topic and teachable. It must be taught, however, from the experimental facts and associated always with illustrations.

In the selection or determination of the approximate atomic weight of an element as the least weight of an element in one molecular proportion of several of its compounds (the mol. wt. being determined by multiplying the gas density to H = 1 by 2, or the density to air by 28.88 and multiplying the mol. wt. then by the experimental percentage composition) and also by the employment of the law of DuLong and Petit (approx. at. wt. $\times$ sp. ht. = k, (k = 6.4), thus approx. at. wt. = 6.4/sp. ht.) with a few problems of each type, the student concentrates his thoughts sufficiently upon combining atomic, approximate atomic, and molecular weights to make a real impression. The definition of an atomic weight as the combining weight of an element to oxygen arbitrarily fixed at sixteen (or by rational selection of one of two or more combining weights) has a real meaning to the student.

The determinations of formulas from the experimental percentage composition and molecular weights involves little difficulty to the average student, using either of the two common procedures (% composition $\times$ mol. wt. $\div$ at. wts. or by % comp. $\div$ at. wts. $\div$ least no. in resulting ratio, clearing of fractions and checking against molecular wt.). The clearing of fractions using illustrations such as phosphorus pentoxide and the occurrence of molecular isomers such as acetylene and benzene should be stressed. The determination of percentage composition of compounds

from formulas involves little or no difficulty if the student has had proper drilling in atomic and molecular weights and formulas.

Calculations Involving Stoichiometrical Equations

The general procedure of a student with a reaction problem, for instance to compute the weight of hydrogen sulfate in dilute solution which reacts with 5.6 g. iron, is to start with the expression, $56X = 98 \times 5.6$ and to obtain, sometimes, the result 9.8, rarely 9.8 g. hydrogen sulfate. Sometimes the student employs an equation. The solution of reaction problems always seems difficult to students drilled in handling proportion as pure mathematics. The secondary school and even college graduate when he starts working commercial problems does not readily meet the expectations of his employers. The employer always views computations from the standpoint of pure and applied reasoning only.

After much experimentation with classes and groups, some members using the procedure normal to them, frequently the apparently short procedure, while others followed the four-step detailed, procedure which is outlined below, the writer has observed that the average student obtains correct results and obtains them more quickly by the latter. This procedure comprises: (*a*) equation, (*b*) statement of equivalence or several statements of equivalence, (*c*) statement of simple proportion, using all factors, (*d*) solution of the simple proportion using every opportunity for cancellation, numerically, and in other terms and for checking results. Likewise in cases where logarithms or slide rule are employed there is the advantage of clearness in procedure. A student may know well that the product of the extremes is equal to the product of the means in a simple proportion but he does not apply it readily in original problems. With the number of problems a student in general chemistry usually has assigned, he starts with the shorter procedure, soon becomes somewhat confused, as can be learned by a little questioning, and obtains a result which he is not sure of. After a test, for instance, the common question in a corridor is "What answer did you get for ——?" With students feeling that their results are probably correct, there comes a greater interest in problems, frequently the zest for them and joy in working them rapidly and accurately. And where is the teacher that does not enjoy the feeling that the majority of his students can work problems well? It is one of the compensations of teaching.

In reaction problems by the four-step procedure we have a method applicable to simple and to the most complex problems. Thinking of the four steps, after a little use of them, the student soon sees how the problem at hand can be attacked and proceeds with confidence. This can best be illustrated by a few problems:

Compute the weight of zinc sulfate formed by action of an excess of dilute hydrogen sulfate solution on 13 g. zinc, to tenths.

(A) (equation) $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

(B) $Zn \equiv ZnSO_4$
65 g. 161 g.

(C) (complete statement of proportion) 65 g. Zn:161 g. $ZnSO_4$:: 13 g. Zn: X
(1)*

(D) (solution of proportion) $$X = \frac{13 \text{ g. Zn} \times 161 \text{ g. } ZnSO_4}{65 \text{ g. Zn}} = 32.2 \text{ g. } ZnSO_4$$
(5)*

* Cancellation.

What volume of hydrogen is obtained under standard conditions by action of 36.5 g. hydrogen chloride in water solution on an excess of iron?

(A) $Fe + 2HCl \longrightarrow FeCl_2 + H_2$

(B) $2HCl \equiv H_2$
73 g. 2 g.
(22.4 l. u.s.c.)

(C) 73 g. HCl: 22.4 l. H_2:: 36.5 g. HCl: X

(D) $$X = \frac{36.5 \text{ g. HCl} \times 22.4 \text{ l. } H_2}{73 \text{ g. HCl}}$$ Cancelled, $$X = \frac{22.4 \text{ l. } H_2}{2} = 11.2 \text{ l. } H_2 \text{ Ans.}$$

What weight of potassium permanganate is used in converting ferrous sulfate from 0.56 g. iron into ferric sulfate in an excess of dilute hydrogen sulfate solution?

(A) $Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$
$10\,FeSO_4 + 2KMnO + 8H_2SO_4 \longrightarrow 5Fe_2(SO_4)_3 + K_2SO_4 + 2MnSO_4 + 8H_2O$

(B) $10\,Fe \equiv 10FeSO_4$
$10\,FeSO_4 \equiv 2KMnO_4$
$2KMnO_4 \equiv 5O$
$10Fe \equiv 5O$
560 g. 80 g.

(C) 560 g. Fe : 80 g. O:: 0.56 g. Fe: X

(D) $$X = \frac{0.56 \text{ g. Fe} \times 80 \text{ g. O,}}{56 \text{ g. Fe}}$$ Cancelled, $$X = \frac{8 \text{ g. O}}{100} = 0.08 \text{ g. O Ans.}$$

Conclusion

Although nothing new in principle is stated, attention is directed to difficulties encountered by students in working general chemistry problems. These can be eliminated largely by teaching the procedure on a reasoning basis as outlined and illustrated. Problem work is a necessary and important part of a student's course in general chemistry and we must use every means to develop interest and inspire confidence in it.

A METHOD OF AVERAGING GRADES IN LABORATORY COURSES

LYMAN E. PORTER, UNIVERSITY OF ARKANSAS, FAYETTEVILLE, ARKANSAS

The final grade in a laboratory course is fixed ordinarily by the consideration of at least three distinct numerical grades for each student, namely, laboratory work, class work, and the final examination. The weights to be assigned to each of these units will vary with the nature of the particular course. Unless the averages of the class for each of these units are at least approximately the same, even the weighted grades derived from these will not give a correct estimate of the relative abilities of the students in the class.

Take, for example, a class in qualitative analysis in which the final laboratory-work grades range from 75 to 98, with a class average of 90, and in which the class-work grades range from 40 to 90 with an average of 60. An average student, A, receives a grade of 90 for laboratory work and 60 for class work. The resultant of these is 75. Student B receives 95 for laboratory work and 55 for class work. The resultant here is likewise 75. From a consideration of the wide numerical range of the class-work grades and the limited range of the laboratory grades for the entire class, it should be evident that the difference of five points in laboratory work ought to be of more significance than five points in class work. In the cases cited above, student B should, therefore, receive a higher grade than student A, whereas by the ordinary process of calculation, the two grades work out to be identical.

To eliminate this situation, the author has used the following scheme for four years with considerable satisfaction. The class-work averages for the members of the class are made out in the usual manner. These are then arranged in numerical order, the highest grade standing at the top of the list. The student receiving the highest grade is given the number one, the second highest the number two, etc. In the case of a tie, identical numbers are given. Thus, if the grades in a class run 90, 88, 88, 85,—, the numbers assigned would be 1, 2, 2, 4, —, respectively. The same procedure is employed in determining the corresponding number for the laboratory-work grade. When these numbers for each student are added together, a number is obtained which may be designated as the ranking number for the student. A comparison of the ranking numbers of the members of the class gives a relative measure of the rank of these, the better ones having the smaller ranking numbers.

Suppose the students A and B, cited above, are in a class of twenty. Student A would receive number 10 for class work and 10 for laboratory work, or a ranking number of 20. Student B would receive perhaps 12 for class work and 4 for laboratory work, or a ranking number of 16.

This would give student B a higher ranking than student A, which is what he really deserves.

This method may readily be extended to include the examination and other grades. Suppose the total grade is to consist of class work (two units), laboratory work (two units), and final examination (one unit). In such a case the numbers obtained for the laboratory grade and for the class grade would each be multiplied by two and added to the number obtained for the final examination to give the ranking grade. These may then be placed in numerical order, and letter grades assigned to each student. There is no reason why the ranking numbers should not be converted into (relative) numerical grades on any scale desired. Any weightings may be given to the various units, and additional units may be added to meet the requirements of any class, whether in chemistry or in any other subject.

The author believes that this method of making out the final grade is fairer to the students than the ordinary "averaging" method in courses where, by the nature of the work, the numerical averages of the different units for the whole class are not the same. It has been his experience that students, to whom the system has been explained, comment upon what they choose to call the "fairness" of it.

Large Crystals and X-Rays Reveal Metal Secrets. Delving into the mystery of the interior of metals, metallurgists have reported to the American Institute of Mining and Metallurgical Engineers success in making large single crystals of various metals some of them half a foot long.

Ordinary metals are large groups of minute crystals, usually so small that a microscope must be used to make them visible to the eye, although almost everyone has noticed the large crystals that can be seen in the zinc coating on galvanized iron. Metallurgists believe that in crystal behavior lie the secrets of how to work and manipulate many metals and alloys. Since the X-ray spectrograph, which is used to examine the internal metallic structure, operates most satisfactorily when a single crystal is used, various ways have been devised to make single crystals as large as possible. Samuel L. Hoyt of Schenectady, N. Y., described how he had made zinc crystals about as big around as the graphite in an ordinary lead pencil and 4 to 6 inches long. Large single crystals of steel, tungsten, aluminum, and other metals have been made by various methods involving annealing or sudden cooling, Orlando E. Romig, of Vandergrift, Pa., told the engineers.—*Science Service*

Thyroid Hormone Now Made in Laboratory. Thyroxin, the hormone of the thyroid gland, has been made synthetically for the first time in the laboratories of University College, London, according to reports just received by the American Medical Association.

Dr. C. R. Harington and Prof. George Barger are the workers who have achieved this result from researches supported by funds supplied by the Rockefeller Foundation to the University College Hospital Medical School in 1920. The hormone, which is used in treating patients with a defective thyroid gland, was first isolated by Dr. E. C. Kendall of the Mayo Clinic in 1917. Its production synthetically from coal-tar products and iodine will assure an absolutely even standard, medical authorities say, and should have the effect of making the price much lower.—*Science Service*

A NEW LABORATORY PROCEDURE FOR THE ELECTROLYTIC DETERMINATION OF THE COPPER CONTENT OF BRASS

LAWRENCE E. STOUT, MIAMI UNIVERSITY, OXFORD, OHIO

Frequently in a small laboratory a teacher of quantitative analysis finds himself unable to give his students any exercises in electroanalysis because he has no source of direct current. It is the purpose of this report to show how such a teacher may give his students practice in this very fundamental phase of quantitative analysis even though he has only the customary 110 volt A. C. current at his disposal.

Apparatus

A very simple form of "chemical rectifier" may easily be made from apparatus common to every chemical storeroom. The following materials are needed: four 250-cc. wide-mouth bottles (gas collecting bottles); four two-hole rubber stoppers to fit; four pieces of sheet aluminum, $1'' \times 6''$; four pieces of sheet lead, same size as the sheets of aluminum; a little copper wire; about a liter of saturated $NaHCO_3$ solution; two cleat base receptacles; and two sixty-watt lamps.

The metal plates should be cut down at the top so that they may go through the holes of the stoppers, and protrude far enough on top to afford opportunity to make the connections. It is best to drill a third hole in each stopper to allow the gases liberated within the bottles to escape. The wire connections are made according to the wiring diagram, Figs. 1 and 2.

The quantity of current desired can be regulated somewhat by the size of the lamps used in the hookup. The larger the lamp, the greater the quantity of current. It was found that two sixty-watt lamps gave a current that was correct for the electrodepositions studied in this report. In this work, as indicated by the diagrams, Figs. 1 and 2, a voltmeter, an ammeter, and a rheostat were available, and therefore used. It was found, however, that when conditions were standardized as specified, that these instruments were not necessary unless a more detailed check on current conditions was desired than that ordinarily necessary in beginning work.

A platinum gauze electrode of approximately 103 $cm.^2$ area was employed as the cathode. The anode was an ordinary platinum wire about 3 cm. long.

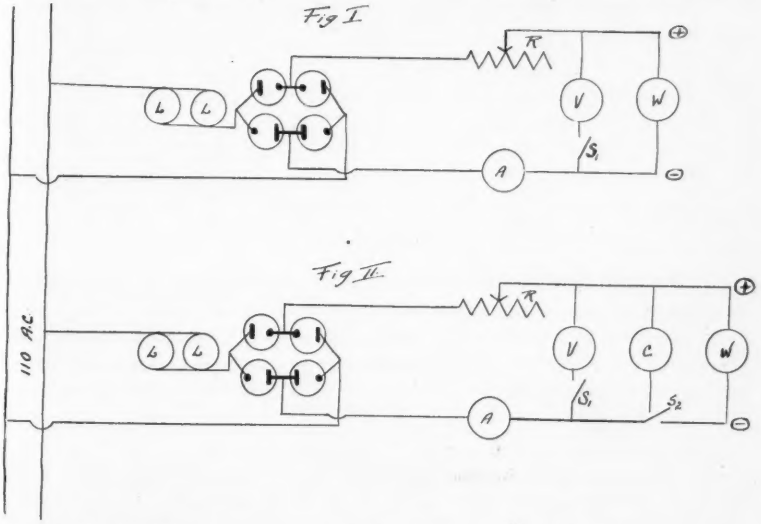
Experimental

The experimental work is divided into two parts as follows: (1) An experimental demonstration that this source of direct current gives an analytical result in the hands of beginning students in quantitative analysis

which is sufficiently accurate to be within the limits of experimental error. (2) The development of a curve for the rate of deposition of copper from a 0.25% solution of copper sulfate.

Part One

Twelve average students in beginning quantitative analysis were required to run electrodepositions on the copper content of brass using the "chemical rectifier" as a source of current, and then to repeat the determination using a bank of storage batteries for the source of current.



■ = Pb plate ● = Al plate L = Lamp
W = Decomposition cell S = Switch V = Voltmeter
A = Ammeter R = Rheostat C = Auxiliary cell

The Foulk method (Foulk, "Notes on Quantitative Chemical Analysis," page 233) was employed, except that the gauze electrode mentioned above was substituted for the flag electrode specified by Foulk.

Since the experiments conducted demonstrated the errors between the two methods of analysis to be in the main smaller than the limit of experimental error allowed beginning students, it was concluded that the apparatus gave sufficiently accurate results to be used in beginning quantitative analysis.

Part Two

We were interested in finding out something concerning the rate of deposition of copper under the conditions of the experiment. In using the

"chemical rectifier" it was noted that some few minutes were required before the current conditions would settle down and become constant. Therefore, it was necessary to place an auxiliary cell, C (figure two) in the circuit until the rectifier had attained a constant rate of current delivery. The switch S_2 was then thrown so as to send the current through the decomposition cell, W, and the measurements made.

TABLE I

Time min.	Wt. of Cu deposit	Amps.	Volts	Temp.
15	0.0107 g.	0.05	5.5	21
30	0.0259 g.	0.06	5.5	20
60	0.0524 g.	0.055	5.5	25.5
90	0.0765 g.	0.06	5.5	24
120	0.0909 g.	0.06	5.0	20.5
150	0.1058 g.	0.06	5.5	19.6
180	0.1087 g.	0.06	6.0	20
225	0.1169 g.	0.085	6.0	22
240	0.1186 g.	0.09	6.0	21
339	0.1189 g.	0.06	5.0	21

Conclusions

1. The apparatus described above is very satisfactory for student use in practice determinations of the copper content of brass.

2. Under the experimental conditions used in part two, the copper content of 200 cc. of approximately 0.25% copper sulfate solution may be deposited in 240 minutes.

Salt Recommended for Dyspepsia. Common salt is as effective as any other remedy for dyspepsia according to reports of research at the University of Melbourne, Australia, recently received. Dr. F. A. Apperly has found that common salt helps certain types of plain dyspepsia.

Doctors have long been puzzled because either sodium bicarbonate or hydrochloric acid, direct chemical opposites, proved efficacious in remedying some dyspepsias. The reason appears to be that the governing factor is the total salt strength of the stomach contents and not the reaction. The contents may be either right or wrong as to acidity but if the salt strength as a whole differs from that normally in the small intestine at rest, the intestine will promptly reject the mixture back into the stomach until it is of the right concentration. This rejection prevents the stomach from emptying and, in time, gives the patient also an unpleasant sense of fullness.

Taking either hydrochloric acid, sodium bicarbonate, or common salt will, in any case, increase the salt concentration of the stomach contents of such patients until this equals that of the contents of the small intestine. Then the intestine ceases to reject the mixture from the stomach and digestion proceeds without discomfort. Needless to say, no patient can casually experiment with himself, and an examination of the stomach contents remains obligatory in any scientific treatment of dyspepsia, but Dr. Apperly's finding clears up the mystery so far surrounding the nature of certain types of simple dyspepsias.—*Science Service*

CHEMICAL INDUSTRIES EXPOSITION

At the meeting of the Advisory Committee of the Chemical Industries Exposition held at the Chemists' Club, 52 E. 41st St., New York City, Thursday evening, February 10th, with Dr. Arthur D. Little of Boston presiding, numerous details of the coming Exposition to be held at the Grand Central Palace, September 26th to October 1st, inclusive, were planned and discussed at length.

Mr. Charles F. Roth, co-manager of the Exposition reported very excellent progress with the Exposition to the Committee and that three floors of the Grand Central Palace already had been reserved.

The interest in the Chemical Industries Exposition shown by the leading educational institutions throughout the country is particularly gratifying. The Students' Course which will be conducted during the week of the exposition is divided into two groups, the first or elementary group and the second or advanced group. The results of such courses are very interesting and an extract from a letter from Professor W. T. Read, head of the department of chemistry at the Texas Technological College, Lubbock, Texas, reads:

> An examination of the rolls for the two previous years brings out the varied types of students registered. Typical college undergraduates, some graduate students, some college instructors, and even professors. Some men of wide and varied industrial experience, and several young men in the industrial field definitely sent by their companies to attend the course. Naturally a considerable proportion of the group have no interest in academic credit of any sort, but are deeply interested in the subject matter of the course. I noticed during the last course that a number of exhibitors dropped in to hear the lectures. It should also be noted that a very considerable number of institutions are represented in our records. In general I think the course has shown a reasonable and satisfactory growth.

It is evident that the value of such courses as those conducted by Professor Read is recognized both by the educational and industrial world and much credit is due Professor Read for the systematic and thorough manner in which the courses are being conducted. At the coming Exposition the speakers on the students' course will include such men of note in the field of Chemical Industry as Dr. Arthur D. Little; H. E. Howe, Editor *Industrial and Engineering Chemistry;* William Haynes, President "Drug and Chemical Markets;" Dr. Charles H. Herty; Arthur Wright, Filtration Engineers, Inc., of New York; S. B. Kanowitz, Raymond Bros. Impact Pulverizer of New York; W. A. McAdams, Massachusetts Institute of Technology; Otto Mantius, New York; A. E. Marshall, Corning Glass Works, New York; E. J. Sweetland, United Filters Corp., New York; H. N. Spicer, The Dorr Company, New York.

Prominent among the features will be the various geographical exhibits divided as follows: The Southern Section by States and railroads to show the raw materials and opportunities of the Southern States; The Canadian Section by Provinces and railroads to show the raw materials of Canada suitable for industrial development. The Container Section, exhibiting containers used in industry with the machinery for packaging, bottling, and labeling; and a Laboratory Supply and Equipment Section. The sectional exhibits will be supplemented by displays of chemical products, machinery used in manufacture and development, dyes and fine chemicals, as well as instruments of precision, unit processes developed and in operation.

One of the features, the date for which was decided by the Advisory Committee, is the designation of Wednesday evening, September 27th, as the date for the American Chemical Banquet. Notification with complete details will be sent to all societies meeting during the week of the Exposition. These banquets have been sponsored by the Salesmen's Association of the American Chemical Industries with the coöperation of seventeen other national organizations and it is expected that this same coöperation will exist at the coming exposition. The designation of this date by the committee is to avoid conflict with other events during the week of the Exposition.

Many new features are being planned for this coming Exposition. One of interest is the change in policy which will admit exhibits of foreign manufacture for showing in the Exposition. This change has been made because the American Chemical Industries are now in such a position that exhibits of foreign products would prove stimulating and at the same time give American manufacturers an opportunity to see what European manufacturers are doing. This change will doubtless bring about a closer relationship in the industry and enable American manufacturers to see and study a number of products and developments of European manufacture that are not produced in the United States.

In as much as the interest lies in industry as a whole, all classes of foreign exhibits rather than one particular type are desired, such as displays by manufacturers and producers of the newer synthetics, dyes, solvents, pharmaceuticals, chemicals and chemical products for direct use in the arts and industries, laboratory supplies and apparatus, instruments of precision and control. To this can be added chemical and engineering equipment for plants and factories, which is of decided interest and great importance to both manufacturer and consumer.

The opening of the doors of the Exposition to foreign manufacturers in the chemical, metallurgical, and numerous industries is the first opportunity for foreign displays in America at an exposition designed for the consumer.

POSITIONS OPEN TO GRADUATE STUDENTS MAJORING IN CHEMISTRY IN VARIOUS COLLEGES AND UNIVERSITIES*

BROWN UNIVERSITY, Providence, R. I.—2 Metcalf Fellowships ($1000); 1 du Pont Fellowship ($750); 1 Rice Fellowship ($700); 3 University Fellowships ($750); 3 University Fellowships ($550); 10 Graduate Scholarships ($300); 1 Graduate Assistantship ($600 plus tuition); 1 Research Assistantship ($1000 plus tuition). All scholars and fellows pay the tuition ($300). Graduate assistants are required to give not over twelve hours of service per week. Scholars and Fellows render no service to the University but are expected to devote the whole of their time to study and research.

DUKE UNIVERSITY, Durham, N. C.—1 Angier Duke Memorial Fellowship ($1000); 4 University Fellowships ($800); 11 University Fellowships ($600); 12 Graduate Scholarships ($300); a number of Graduate Teaching Assistantships ($600–$1000). Holders of fellowships and scholarships will be expected to pay the tuition fee of $60 per year and such additional fees as are regularly required of students. The fees of graduate assistants will be adjusted with due regard to the program of work followed.

GEORGE WASHINGTON UNIVERSITY, Washington, D. C.—A number of Graduate Assistantships for students working in organic or biochemistry. ($600, tuition, laboratory and breakage fee.)

IOWA STATE COLLEGE, Ames, Iowa.—A number of Scholarships ($270, full-time work permitted); a number of Fellowships ($540, full-time work permitted); a number of Graduate Assistantships ($700, one hour over two-thirds full-time graduate work permitted). In each case a fee of $30 for the collegiate year must be paid. These positions are all on a nine months' basis.

LAFAYETTE COLLEGE, Easton, Pa.—A number of Graduate Fellowships ($500–$750). Tuition fees remitted. Laboratory charge of $50.

MUNICIPAL UNIVERSITY OF AKRON, Akron, Ohio.—1 Goodyear Fellowship ($1000); 1 Firestone Fellowship ($1000). Fellows are exempt from all fees, tuition, and breakage. Maximum of nine hours per week laboratory supervision.

PENNSYLVANIA STATE COLLEGE, State College, Pa.—A number of Graduate Scholarships (no salary, exemption of tuition and laboratory fees); a number of Graduate Assistantships ($800, exemption of tuition and laboratory fees).

UNIVERSITY OF ARKANSAS, Fayetteville, Ark.—1 or 2 Assistantships in Chemistry ($600 for half-time work).

UNIVERSITY OF CINCINNATI, Cincinnati, Ohio.—10 Baldwin Fellowships ($500–$750); 6 Taft Fellowships ($500–$750); 2 Fellowships in Chemistry ($500); 10 Graduate Scholarships (free tuition and laboratory fees). All fellowships carry exemption from tuition and laboratory fees.

UNIVERSITY OF COLORADO, Boulder, Colo.—3 One-Half Time Instructorships ($800); 4 Graduate Assistantships ($600); 2 Graduate Assistantships ($500).

UNIVERSITY OF VIRGINIA, University, Va.—A number of Graduate Fellowships ($500).

VANDERBILT UNIVERSITY, Nashville, Tenn.—1 Dudley Fellowship in Chemistry ($300); a number of University Fellowships ($300). Free tuition and laboratory fees.

WASHINGTON UNIVERSITY, St. Louis, Mo.—1 or 2 Fellowships ($500–$750); several Scholarships ($200–$300); 4 Graduate Assistantships ($750). Exemption from tuition and laboratory fees.

WESTERN RESERVE UNIVERSITY, Cleveland, Ohio.—2 Graduate Fellowships for study of gases ($900). Exemption from tuition and laboratory fees.

* Supplementary to list published in THIS JOURNAL, 4, 96–8 (Jan., 1927).

Correspondence

BELGIAN LETTER

The "Société de Chimie Industrielle," the activities of which are well known to every reader of the JOURNAL OF CHEMICAL EDUCATION, held its Sixth Congress at Brussels, Sept. 6–Oct. 2, 1926. This Congress, the first one held outside of France, was organized by the Belgian scientific societies and manufacturers who contributed by all means to the success of this important manifestation. As it is, this Congress is now considered as the most important chemical event ever seen in our country.

We are pleased to summarize for the benefit of the JOURNAL readers, the most interesting facts of this Congress which will interest the chemists of the whole world. Twenty-one nations were represented, and nearly nine hundred delegates attended the meetings.

Some very prominent men of the United States were sent as delegates by their country: F. C. Cottrell, Director of the Fixed Nitrogen Research Laboratory, delegate of the American Institute of Mining and Metallurgical Engineers; J. V. N. Dorr, President of the Dorr Company of New York City, delegate of the American Chemical Society, treasurer of the American Branch of the "Société de Chimie Industrielle;" E. Fullerton Cook, delegate of the American Pharmaceutical Association; G. W. Muhleman, St. Paul University, Minnesota, delegate of the American Chemical Society; A. H. Wethey, delegate of the American Institute of Mining and Metallurgical Engineers.

Since our space is too limited to permit a full account of the Congress week, let us only mention the two main parts of the program, *i. e.*, the section meetings and the visits to works and factories.

A total of 122 papers was read before the following sections:

(1) Works and Laboratories.
(2) Fuel.
(3) Metallurgical and Mineral Industries.
(4) Organic Industries.
(5) Agricultural and Special Industries.
(6) Economic Organization.

Among the fifteen presented in the first group we noticed: "Microchemical Methods Applied to Industrial Tests," Goubeau; "Methods for Analysis and Researches of Secondary Minerals of Uranium," A. Schoep; "Physical-Chemical Standards," Timmermans; "Evolution and Actual

State of Analytical Chemistry," A. Kling; "Determination of Steel Corrosion by Water, and Action of Gases during the Corrosion," Dony.

Among the twenty-two papers of the second group, let us mention: "Industrial Treatment of Primary Tars," Ab der Halden; "Transformation of Cellulose by High-Pressure Heating, with or without Hydrogen," Waterman and Perquin; "The Utilization of Lignite and Bituminous Coal by Carbonization at Low Temperature," Ch. Berthelot.

Among the twenty-two papers of the third group, the following ones were the most remarkable: "Chemical Industry of Katanga," Detrez; "Function of Inert Matters in Lead Batteries," Scarpa; "Action of Weather and High-Temperature on the Properties of Hammer-Hardened Brass," Koenig; "Internal Life of Glass," Lecrenier; "Soluble Silica Analyses in Cements and Mortars," Florentin.

In the fourth group, sixteen works were presented, of which we remember: "The Making of Ketones from Molasses Residuum," Guillissen; "Anti-Oxygen and Tissues Dyes," Gillet; "Photo-Plate Gelatin Insolubilization, by Developing Solutions," Lumiere and Seyewetz; "Some Aceto-Cellulosic Varnishes for Metals," Deschiens.

The fifth group was well attended; thirty-three interesting communications were made, of which we mention only: "Molasses Theory," Dedek; "Baryta—Its Production and Application in Sugar-works," De Guide; "Contribution to the Study of Sugar Crystallization," Berge; "The Crystallization of Saccharose," Kucharenko; "Filtration of Sugar Juices in the U. S. A.," Mariens; "Acetonobutylic Fermentation," Fernbach; "Australian Early Corns in Greece," Papadakis.

Among the thirteen reports of the sixth group, for the study of economical organization applied to chemical teaching and industry, we noticed: "Agricultural Teaching in France," Deschiens; "The Coöperation of Laboratories and Works," Matthis; "Documentary Organization," P. Otlet; "Patents Documentation," Bercovici.

To allow the delegates to attend meetings, lectures, and discussions, each group was subdivided into two or more sections, each of which devoted its attention to a special matter.

The second part of the Congress included visits to works and laboratories as follows:

(1) The *Raffineries Tirlemontoises* are among the largest of the world. The visitors were highly interested in the making, handling, and packing of sugar, as well as in the unceasing supervision of these processes. The social department of the factory is beautifully organized: medical care, pension funds, college scholarships, etc., are largely provided.

(2) The *Usines de fabrication mécanique du Verre* (Libbey-Owens process) at Gompel-Moll, and the *Verreries mécaniques de Zeebrugge* (Fourcault process). These visits gave the delegates a chance to compare

the two processes which wrought a real renovation in the glass industry.

(3) The *Sucrateries de Gembloux* where molasses sugar is recovered by use of baryta.

(4) The *Brasseries Wielemans-Ceuppens*, the most important breweries of Belgium.

(5) The *Savonneries Lever*, using mostly the oil from their own plants in Belgian Congo.

(6) The *Etablissements Cockerill à Liège*, which may be numbered among the most important metallurgical works of the world.

(7) The *Fabrique Nationale d'Armes de Guerre, à Liège*, which gives a very typical illustration of the coöperation between laboratory and works. We intend to write, later on, a special paper on the splendid laboratories of this factory.

The delegates also visited the large and beautiful laboratory buildings of Brussels University, of which we also plan to give a description in the JOURNAL OF CHEMICAL EDUCATION soon. We do not forget, in Belgium, the generous help of the United States of America, thanks to which it was possible to bring our University to its present scale, and to organize that wonderful equipment for study and research, which is today among the largest and the best of Europe.

We apologize for giving but a short and imperfect relation of the Sixth Congress; which was an evident proof of the efficiency of these meetings. These Congresses are useful both to science and to industry, and show the well-doing power of the "Fairy Chemistry."

The readers of the JOURNAL OF CHEMICAL EDUCATION are informed that the "Proceedings" of the Sixth Congress, including papers and lectures in their full text, will be published this year by the "Société de Chimie Industrielle," Paris, and will compose a book of nearly 1000 pages.

FERNAND LAMBERMONT

BRUSSELS, BELGIUM

CHEMISTRY IN THE UNITED STATES AS SEEN BY AN ITALIAN CHEMIST

To relate the impressions that several weeks of daily contact with American chemistry may have occasioned in the mind of an European chemist who had never before visited the U. S. is, for the writer, certainly not an easy task. Much more so if the chemist in question comes from a Latin country and does not well master the American language.

I will, nevertheless, attempt to tell your readers in a plain and frank way exactly how the United States and its chemical world looked to me after a short but intimate contact with several of its distinguished representatives both of the pure and applied branches and after a trip

throughout the country and visits to some of its world-famous factories and laboratories.

In doing this I am perhaps too late; it may be that events which occurred four or five months ago, and conclusions therefrom are not liable to still interest readers of the new world, if it is true that they take interest only in "latest news." But I do not think this to be true; besides, being late, I have not been hurried; so I believe that my thoughts have not been deprived of careful consideration. Ripe fruits, late in the season, are better than unripe, early ones.

Like many of my European colleagues, who visited the United States for the first time, I came boasting a certain baggage of "Kultur" upon American facts and American chemical affairs. Knowledge of facts and affairs that, having been acquired through the study of books, reviews, and papers, had that characteristic lack of reality and *couleur locale* that every traveller can so well evaluate. Personal contacts prove so often a blessing in judging of other communities and are, therefore, not only instructive but useful and necessary.

My contact with your country was very intimate from the very first day. Soon after landing in New York, and having had but a glimpse of 42nd Street and its gigantic sky-scrapers—which, by the way, appeared like old acquaintances, thanks to pictures and moving pictures seen in the old world—I proceeded to Williamstown, Massachusetts, in the heart of delightful New England.

Daylight saving and standard time, joined with the changing of astronomical hour to puzzle the newly landed Italian chemist who, after having, to his astonishment, learned that no first, second, or third class compartments were to be expected in the railways of democratic America, safely arrived at the Williamstown Institute of Politics.

There the very first American chemist I met—he was kindly waiting for me at the station—was H. E. Howe and I can think now of no other man who could have given me a more faithful and agreeable impression of the pure bred, dynamic, courteous but matter-of-fact type of American chemist. This leader of round-table chemical conferences at Williamstown subsequently saw to it that the work of his group was carried out according to schedule, did not admit slackery in any sense, and revealed to me a real leader whose iron hand was clothed with a velvet glove.

The kaleidoscopic personal acquaintances which I happened to make, *à tour de role*, during four weeks, with American chemists specializing in power, raw materials, food or hygiene, will have a lasting influence upon my chemical education.

In Williamstown I found also Dr. McDowell, whom I had had the pleasure to meet in former years in Europe, and who was leading round-table conferences on fertilizers, and we had a few but cordial chats on

subjects of mutual interest, with great benefit to my knowledge of American chemical affairs.

I liked very much the way American chemists, assembled in Williamstown, tackled the questions in which they were interested. Of course, there is no great difference from what we European chemists do on similar occasions, but for the fact that you people surround every subject you discuss with an atmosphere of practicality that makes things appear in a different light from that in which we are accustomed to see them over here.

Speaking of power transportation and electrochemical industries, for instance, Dr. Davis had such new, elegant, and realistic conceptions of power transported through lines and power stored up and occasionally transported through products, that I could but admire and agree with his conclusions.

When the puzzling question of industrial waste arrived, Dr. J. E. Teeple came in with statements that I had never heard of before from lecturers who had ever tackled a similar subject, but I could not help but agree with several of his utterances which contained a good deal of practical wisdom and industrial personal experience.

The aggressive way Mr. Doherty attacked waste in the petroleum industry and his warning against blind faith in inventions bound to come from just "round the corner," in which faith the greatest of wastes are often committed gave me abundant matter for reflection. Why should the American petroleum industry not have a dozen more Mr. Dohertys?

In discussions on energy Dr. A. C. Fieldner was at all times prominent, furnishing data or answering questions or warning the super power plant specialist that the biggest manifestation of super power in the United States was scattered throughout the country in millions of four-wheeled vehicles whose inefficiency as power generating units must be first taken care of if real progress is to be expected in the field of power generation.

The way health, life, and human efficiency problems were discussed also attracted my attention as a case of the very characteristic American way of looking at things practically.

But these are not all of my round-table impressions and it would require too much space to go into them more deeply or to speak of the numerous distinguished chemists with whom I had opportunity to talk.

Coming to the Williamstown, non-chemical public, let me tell you that I was amazed at the way this public followed lectures, discussions, and talks, day, afternoon, and night, for four full weeks, untiringly and with keen interest. It was evident that President Garfield was well justified when—against the advice of some so-called experts—he wisely decided that technical subjects should be included in the programs of the In-

stitute of Politics. It is a reason of pride for us, that chemistry should be chosen, to begin with.

Under such circumstances it is not surprising to me when I read in the JOURNAL OF CHEMICAL EDUCATION of the steady progress which general chemical education is making in the United States.

In the interval between the Williamstown session and the Philadelphia convention, I had the very happy surprise of quite accidentally meeting Dean Hermann Schneider at Cincinnati, Ohio, and learning something about his coöperative high-school system of education. So I—industry owner and professor of industrial chemistry—could see in its full reality what had been and remained my dream in Italy for the past few years; so I could once more say to myself that the best lesson that we of the old world come to learn in the new one, is summed up in one word: coöperation. Just so, should I today summarize my impressions of the United States in the most concise way possible, I think I would only say this magic word, coöperation.

That explains, in my opinion, why things succeed in your country that had never before succeeded in the world. It is not that your people have ideas that are quite new (it is, by the way, so difficult to have quite new ideas, after so many centuries of civilization) "Nihil sub sole novi." Rather, you Americans, have over again and afresh old ideas which had failed to succeed in the old world; but which achieve success in your country because of your different mentality and attitude of spirit. That is why a real coöperation of industry and school, in the way Dean Schneider conceived it, was a success in the United States when the same idea had failed over and over again for decades in Europe. That is why, in starting an educational, a safety, a waste, an efficiency, or whatsoever campaign in your country, you can rely upon the intelligent coöperation of your public, which is the best factor to make it a success; whereas the lack of coöperation of the public in the old world—Latin countries especially—brings the same noble efforts to failure.

Coöperation and standardization, this latter especially, of course sometimes kill that spirit of personal initiative and individuality that we Latins are so proud of, so fond of, so attached to, so bound to for ethical and historical reasons. But I must agree that from a modern point of view (for the so-called civilized life as it is today), your policy is the best, if not the only one, that should be adopted.

Coming to the Philadelphia and Washington meetings, the recollections are so numerous and impressions so various that I am not at a loss to pick out some, save for fear of writing too much at length.

The rally of American chemists at Philadelphia was impressive and the fact that the United States has but one American Chemical Society with well over 16,000 members should be a lesson to some much smaller

countries where chemical associations are plentiful, although, of course, much less patronized and scattered all over the country as independent units.

Events seemed to go smoothly by themselves at the meetings and during the subsequent trip but, thanks to a little personal experience in such matters, I could quite realize the amount of organization work Dr. Charles L. Parsons and his associates—Dr. Hale and Dr. Keyes especially—had accomplished for the occasion.

Dr. Parsons—who is, by the way, together with Dr. Seidell, of Washington, just as popular in Europe as he is in the States—has often caused me to wonder how he can do such an imposing amount of work as he is called upon to do, and never be hurried or out of temper. Perhaps the fact that he remains unhurried permits him to attain a higher degree of efficiency.

American scientists—several of whom I had met previously in Europe and met again at Philadelphia and Washington—are in my opinion peculiar for the masterly way in which they can talk pure science in tackling subjects of an applied character. Dr. J. Langmuir's lecture on "Flames of Atomic Hydrogen," at Philadelphia, was a masterpiece in that direction. The same may be said of Dr. W. P. Davey's talk on "Circumstantial Evidence of Atomic Structure," or of Prof. F. C. Whitmore's and Dean G. Wendt's talks on structural chemistry, for the general public at Williamstown.

American chemical plants, as we were admitted to visit them, are such that they will never be forgotten by people who have lived in the factories of the old world. Du Pont at Wilmington or Kodak at Rochester, the steel industry at Pittsburgh or the rubber industry at Akron, Dow at Midland or Parke, Davis at Detroit, to say nothing of Ford, Niagara Falls, and so many other interesting factories, are the material proof that the golden age for chemical industry is just now at its best in the United States. Summing up the situation, let me say that the meetings and following round trip, left us foreign delegates really charmed and satisfied with the feeling that everything had been done to make our stay as pleasant and instructive as possible.

Scientific chemistry is progressing at a very rapid pace in the United States thanks especially to coöperative research work; thousands and thousands of well-established scientific facts are being collected daily in hundreds of well-equipped research laboratories. I do not feel that some of the American research laboratories look better than some of our European ones. I should rather say that, taken altogether, they look worse as to general aspect and upkeep, although they give a good impression of efficiency. This fact astonished me rather, considering the large sums of money and staff generally at disposal in the American laboratories.

American chemical industry impressed me for the standardization of its products and its very reduced labor, for the magnitude of its units and the great amount of controlling apparatus on chemical equipment.

Units, although very large, seemed in general to be of a simple scheme of construction. The general aspect of factories—upkeep, cleanliness, and organization—did not seem to me better than in Europe, on the average.

The spirit of scientific application in industry appeared to me remarkable, and this is no wonder with leaders like Dr. Reese at Du Pont's and Dr. Mees at Kodak's and with men like Baekeland and Dow, former professors of chemistry, at present also leaders of large chemical concerns.

I feel really that American chemical industry is not always very progressive as far as adopting new chemical processes is concerned; in other words any new chemical process whatever, will, with less difficulty, find a chance of application in Europe than in the United States. I need not state examples, though I might give many, but I stress this point because it is contrary to the general belief in Europe that a new process will with greater ease find its way in the new rather than in the old world. This belief comes from the fact that wealth being much greater in the United States, Europeans expect America to invest much more freely than Europe.

From an industrial and financial point of view I can, however, perfectly understand American mentality in this connection. The country being a wealthy one, money can find its investment in comparatively easy earning industries; no reason then to risk in new chemical enterprises, which are often financial failures in the years of *mise au point.* Here again we find, therefore, a perfect distinction between American and European mentality and attitude.

To talk of dollars and cents is a very useful habit, a necessity I would say, not only for the financial, industrial man, but also for the technical one; it should, however, not be forgotten that a new process that might not net much for the first or second year often brings a multiplied return in subsequent years.

As for general chemical education, I find that the United States is well in advance of Europe. Meetings, exhibitions, radio lectures, magazines, popular talks or books by qualified scientists—Slosson's books are a wonder in this connection—everything is put to work to create a popular chemical consciousness, and the success well justifies the effort.

Chemists of the old world have not fully realized yet that chemistry has to become popular if it is to find the large financial and moral support it needs. Some of our scientists live still in splendid isolation and generally believe that talking science to non-scientific people partakes of the nature of a profanation.

Let me finally add that sailing for the United States I was of the opinion that democracy represented an American ideal not well and not fully applied in the territory; coming back to Europe I had, however, changed my mind to the opinion that democracy is a real fact in the United States and that no other land could give a better demonstration of how democracy contributes to the welfare of the whole nation. Therefore, today I am a real democrat in the American way, in so far as the elevation of the lower classes to a higher standard of life is concerned; but still remain an anti-democrat in the European way, which is to say, I oppose the lowering of the higher classes to a poorer standard of life.

I have also realized in the United States that I was wrong in suspecting that money meant everything to the average American. If money plays a great part, I must frankly add that the way wealthy Americans spend their money means much more to the American nation.

I will now conclude my remarks by saying that from the point of view of physiological chemistry I made the astonishing observation that alcohol—after over thirty years' daily use in Italy—had not become a necessity for my body. On the contrary I felt better for my two months dry treatment, and many of the fifty or so foreign delegates said the same. It is a fact that we had not a single casualty during our rather hard round trip and journey, which, in my opinion, was due to our dry dinners and luncheons.

The logical conclusion would be that I stopped wine altogether on returning to Italy; but, let me say it for the sake of truth and the joy of the anti-dry faction among American chemists, I did not. I went back to wine and liquor, and sometimes a good after-dinner glass is the best catalyst for my most pleasing mental wandering over America and American chemistry.

UMBERTO POMILIO

NAPLES, ITALY

University Station Makes Radio Record. A long-distance record for short wave radio transmission was made recently when the University of Minnesota experimental radio station communicated with ARCX, a Norwegian whaler near the South Pole, a distance of 11,500 miles from Minneapolis. A wave-length of 38 meters was used for this transmission, which lasted 60 minutes.

The boat, which was sent out by the Norwegian government as part of an anthropology expedition, was hunting a species of blue seals and, at the time, was only 600 miles from the South Pole and 2800 miles south of New Zealand, according to the message conveyed to operator J. O. Oltobell at the University station, 9XI.

Since 12,500 miles is half way around the globe, this radio message came within a thousand miles of going the maximum distance that a radio transmission could travel.

The university station has recently been rebuilt and this feat was accomplished on the second night of operation. The station is manned by 25 student operators who work in night shifts all night long transmitting messages. An arrangement was made with the Norwegian vessel whereby communication will be attempted every Wednesday morning at 5:19 Central Standard Time.—*Science Service*

Chemical Digest

SOME ABSTRACTS OF PAPERS TO BE DELIVERED AT THE RICHMOND MEETING OF THE A. C. S.

Comparative Results Obtained by New and Old Methods of Analyzing Group III

M. C. Sneed, G. B. Heisig, and G. Trovatten

A modification of the analysis of Group III of the cations is discussed. By means of ammonium carbonate and hydroxide the manganese ion is precipitated as the carbonate along with the hydroxides of iron, aluminum, and chromium immediately after their separation from nickel and cobalt. In this way the zinc is separated from the other ions early in the procedure.

Lead acetate is used to detect the presence of the chromate ion. The presence of aluminum is confirmed by the use of aurin tricarboxylate. The results obtained by a number of classes using the old and new methods are given.

What Chemistry Should Every Adult American Know?

John C. Hessler

The question resolves itself primarily into the means of securing a usable residue from the high-school chemistry course, as well as the extension of the election or requirement of chemistry to a much larger proportion of high-school students. The main purpose of such instruction and training is to clarify common thinking about common things. Every adult should understand the bearing of the chemical point of view upon his own thinking and upon his acts and those of the community. The residue should include at least:

(1) The distinguishing characteristics of mixtures and single substances.

(2) What we mean by the properties of a substance.

(3) Substances react in definite proportions by weight.

(4) Chemical change is a transposition of elements and energy.

(5) Chemistry is at the foundation of modern material life.

The illustrations by which this chemical knowledge is conveyed, whether in schools or by popular lectures, should be so fundamental

and common that they will be retained and used ever after in common thinking and behavior.

Science Survey of South Dakota

J. H. JENSEN

The Science Survey conducted in 1924 and 1925 shows that 96 per cent of the four-year state-accredited high schools are located in towns of 2500 or less; 74 per cent have an enrolment of less than 100; 60 per cent of these schools employ three or four teachers. Out of a total of 459 per cent science instructors, 31 per cent serve as superintendents or principals and, in addition, two-thirds of the latter group also teach five to six classes per day, usually a two- to three-subject combination such as science, mathematics, history; average salary of science instructors excluding those serving as superintendents or principals is $1425; 34 per cent have two years' teaching experience or less, with 42 per cent of the science instructors in the present position for the first year. Average value of equipment is chemistry $387, physics $377, biology $188, general science $134, physical geography $65, with an average of $140 spent for new equipment. Science taught is largely determined by the previous subject-matter training of the teacher employed and is not based on the needs of the pupils. Instructors are so overloaded with work that they cannot adequately prepare for class and laboratory work. The content of the course is determined by the text-book used, not adapted to local conditions.

On basis of survey conducted in 1917 by Dr. H. I. Jones and that of 1925 by the author, we find that in 1917, 47 schools offered general science and in 1925–84 schools, physics 71 to 76, biology 54 to 49, chemistry 21 to 41, physical geography 78 to 21.

The Projection of Lecture Experiments

HARRIETT H. FILLINGER

A projection lantern for opaque objects has been found to be very useful in projecting certain lecture experiments thus making clearly visible to every member of a large class the details of lecture experiments which are often seen by only a small per cent of the class. Some of the lantern's uses—such as demonstrating relative degrees of ionization of strong and weak electrolytes as shown by conductivity of electricity and chemical activity experiments, fractional precipitation and "dissolving" of in-

soluble compounds, double refraction of Iceland spar, and crystallization from supersaturated solutions—are discussed and illustrated.

The Periodic Table as a Teaching Aid in Qualitative Chemistry Courses

H. A. GEAUQUE

The solubilities of the simple salts of the metals decrease from left to right and downward in the periodic table as arranged by the writer.[1] Each group of the qualitative system is shown by a different color and the valences are given. This method shows the first group in the lower right-hand corner of the table while the fifth group is found in the upper left-hand corner. The qualitative grouping follows the general increase in solubility of the salts. The table also groups metals that form soluble hydroxides, amphoteric hydroxides, and salts which are soluble in an excess of ammonium hydroxide, etc.

Opportunities in the Chemistry Profession

A. SILVERMAN

The paper covers distribution fields of endeavor in the application of chemical science together with the number of men and women employed in the various fields. Prospects for advancement are considered together with graduate fellowships, salaries, prizes, medals, and awards, such as the Nobel Prize. The relative advantages of Bachelor's, Master's, and Doctor's Degrees are studied with a consideration of the type of position and monetary return that may be expected. The paper also includes advancement to higher offices in industrial corporations and to positions of responsibility up to the presidency in colleges and universities.

Essentials of General Chemistry

C. A. BRAUTLECHT

It is quite generally recognized that the average young man who attends our colleges today is apparently not gaining as thorough a knowledge of the essentials of chemistry as many persons inside and outside of the

[1] THIS JOURNAL, 2, 464–66 (1925).

colleges believe he should. There are many factors involved such as aptitude and previous preparation of the student, size of text, insufficient time for thoroughness, extra-curricular activities, and even what the essentials or fundamentals are. The writer considers the elimination of pictures of chemists and of all historical data excepting the year of discovery desirable in elementary or general texts.

What a student gets out of the electron theory, colloids, and radioactivity that he can use later, is considered questionable when there is insufficient evidence that he has actually mastered, previously, the fundamental laws, the determination of atomic and molecular weights, the deduction of formulas, computation of gas volumes with temperature and pressure changes, computation of quantities of substances involved in reactions, expression of reactions, etc. The possible value of atomic structure is compared to a real understanding of the common important elements and compounds as taken up in the systematic order: date of discovery, occurrence, separation or preparation, physical properties, uses, important related substances, and any specialty associated with the substance.

The writer makes a plea for greater simplicity in elementary chemistry, inductive teaching, smaller texts, and more thoroughness.

A Suggested Course in Quantitative Analysis

J. SAMUEL GUY

This is a course in volumetric analysis in which the student is required to make ten to twelve "prepared solutions" as listed herewith: HCl, NaOH, $(COOH)_2$, $KMnO_4$, $FeSO_4.(NH_4)_2SO_4$, $K_2Cr_2O_7$, $Na_2S_2O_3$, I_2, $AgNO_3$, KCNS, As_2O_3. These solutions are prepared in one liter quantities and of an approximately N-10 concentration. The student then proceeds to establish a complete set of ratios for these solutions by titration. Having established these ratios he then proceeds to establish the definite concentration of any one by some accepted method and from this he calculates the exact concentrations of all the other solutions. Within six to ten laboratory hours the student is able to have a dozen standard solutions and then uses each of these to make some well-known analysis.

The course offers a connected theme from beginning to end, interests the student, requires very little class-room or laboratory instruction, and condenses into a short course much of the best that is covered in a more detailed course in the same field. The text contains a "model experiment" for each procedure offered. All results are explained in the light of the modern ideas of electronic changes.

Sanitation in Pipetting and a Pipet of New Design

ROBERT F. MCCRACKAN AND EMANUEL PASSAMANECK

It is desirable that a pipet be such or have attachments such that the user will not have to put his mouth where his finger has been, nor where another person's mouth has been. Individual mouthpieces of different designs may be used with pipets of different kinds already on the market, and pipets of new design based on ideas covered by expired patent number 553,044 may be made or bought. Some models will be exhibited.

Lecture Demonstration or Individual Laboratory Work for Beginners in College Chemistry

V. F. PAYNE AND R. N. MAXSON

This is a preliminary report of a comparative study of two sections of freshman engineers in the University and two sections of freshmen in a Liberal Arts College. One section in each institution was taught by the lecture-demonstration method and the other section was given the orthodox laboratory work. A new technic for comparing the achievement of groups of unequal ability is described. The results obtained are discussed and an attempt made to interpret the data.

Qualitative Analysis in the General Chemistry Course

WM. B. MELDRUM

Presentation of a system of qualitative analysis of single salts, bases, acids, and oxides now in very limited use in colleges in first-year chemistry. Excerpts from the system itself, the methods of administering the work, and discussion of its pedagogical value. The claim is advanced that the knowledge gained of the reactions of the commoner anions and cations, the working through to definite and logical conclusions, the engendering of the competitive spirit, and the enhanced interest of the student in chemistry, all justify the inclusion of the work in the general chemistry course. The scheme does not involve separations and so does not encroach upon the regular course in qualitative analysis but does afford some preparation for it.

An Experiment in Predicting Student Performance in General Chemistry

MAUDE B. SCOFIELD

The data were gathered from a freshman chemistry class of over 200 students, all of whom had studied chemistry in high school. The final grades in college chemistry have been compared with individual grades in high-school chemistry, physics, and mathematics and with the grades obtained in a preliminary placement examination conducted by the chemistry department of Syracuse University in September. Several correlations warrant serious consideration.

A METHOD OF EDUCATION

Dr. A. J. Carlson,[1] in a recent address before the American Association for the Advancement of Science, cited research as a method of education. In speaking of education he said:

> There is some dissatisfaction with the results of present-day formal education, on the part of the educators, on the part of society, and possibly on the part of those in the process of being "educated." In consequence of this, our educational methods are being subjected to destructive and constructive analysis as never before. Notwithstanding the dissatisfaction, we have extension of formal education to more and more people; the period during which young men and young women are subjected to our formal educational processes is gradually lengthened, we are making increasing financial investments in educational institutions, and despite the criticism we still appear to have an abounding faith that education will somehow save society from many of its errors and follies....
>
> An "educated" man is supposed to have a certain fund of information plus a certain controlled behavior or disciplined emotions. He is supposed to have acquired a certain degree of critical judgment as a matter of automatic cerebration; a certain method of arriving at conclusions by analysis. He is supposed to weigh evidence, to keep an open mind in regard to the unknown. When we survey the behavior of humans today, it is very obvious that critical judgment, except in matters of immediate practical interest to the individual, is largely conspicuous by its absence. The scientific method has not yet become a tool in everyday human behavior. We know more facts than ever before, but, on the whole, we do not seem to be much wiser, more sane and more just than our more ignorant ancestors. This applies to the so-called educated members of society as well as to those who have come in the least contact with the formal educational processes of today.

Our present educational methods are designed to impart the maximum amount of information in the minimum of time. In formal education the student is seldom permitted to learn by doing. Education by dictation begins in the home. Dr. Carlson continues:

[1] "Research as a Method of Education," *Science*, **65**, 125–8 (Feb. 4, 1927).

Even students in the colleges or professional schools, preparing themselves for the so-called scientific professions (engineers, chemists or physicians) may, and usually do, go through the four years of college, and the four or more years of their special professional schools, without being compelled, without having the privilege as a part of their formal training of meeting and solving problems where the answer is not known. I speak with some knowledge of the situation in the field of medical education. Here (and I presume this is typical in chemistry and in engineering), the rate of increase of facts and theories is so great that if we expect even the ablest of our students to master them all or even a considerable fraction of them, before he is admitted to the practice of his profession, he will have neither time nor energy to practice science.

Science is a recent adventure in education. Philosophy, mathematics, languages laid down the general methods of education before science was admitted to the curriculum. Now, science itself has largely assumed the easier method of the older university disciplines, the method of memory-cramming, lecturing and spoon-feeding, even for those who are on the way to become more or less professional scientists (engineers, chemists, physicians) instead of holding on to the method by means of which science grows, namely, the method of *doing*.

Dr. Carlson does not contend that the student at any stage should cease to profit by past experience or should cease to learn from books. He believes that the student should be permitted, if not compelled, to answer questions, not from books or lectures, but by field investigation or laboratory experimentation. He examines the objections which naturally arise as follows:

The weaknesses of my thesis are partly known, and more may develop if a universal attempt should be made to put it into practice. In the first place, there would be some loss of time. The student, left partly to himself to learn, would err, as do even the wisest of adults, in unknown territory. If part of the student's time is to be taken up by making errors and correcting them, he will have less time to cram his brain with "ten thousand useful facts," and this will handicap him in the race with his fellows in all tests based on memorizing these "useful facts." Secondly, the life of the teacher would be made more distracting and laborious. It is easy to lecture to a group of a hundred pupils, to quiz such a group on a textbook or to assign "required reading." Turn the same hundred students loose on problems and the same teacher will have an interesting time, indeed! Thirdly, the introduction of even a small modicum of direct field or laboratory work on the part of every pupil will call for enlarged material facilities all along the line, and tax the ingenuity of the teaching force to the utmost in supplying materials. This will make the plan unpopular with the teacher who is inoculated with the perverted union labor ideal of the least effort that the traffic will bear, but I believe it would make better teachers of us all.

It is obvious that not all people who have been trained in the method of science by actually doing new work show that this training has materially affected their conduct in every-day life or their judgment in practical affairs. To this Dr. Carlson replies:

This seems to challenge my primary assumption that training and practice in research will establish the scientific method as part and parcel of the behavior mechanism. We have, indeed, the phenomena of "double personality" or "water tight compart-

ments" in the brain, in consequence of which a man may be rational in one particular field, but foolish and unfair when he steps outside of this field, and training in scientific research has not yet eradicated this defect in the scientists themselves. Must we, therefore, abandon the idea that such training modifies behavior in the direction of sanity? Without knowing all the factors in the phenomena, and hence admitting that the question is an open one, I nevertheless venture the following suggestion. Foolish or unfair behavior of normal persons who have adequately assimilated the scientific method is not inherent in the physiological mechanism and therefore irreparable....

Accordingly, I do not claim that the introduction of research as a part of education at all stages will make all normal men sane all the time. I think it will help to make more men sane on more matters for a greater part of the time.

Dr. Carlson concludes his address by saying:

I am not sufficiently myopic to promise that individual research as a part of education at all levels will be a panacea against all the credulity and unreason of normal men. In urging it as a hopeful experimental therapy, I do not put undue emphasis on the hope, because society will interfere or try to interfere with the experiment. There will be interference on the part of teachers who are satisfied with present methods. And in any event we start with material already processed in *education by dictation* at the hands of parents and priests.

W. R. W.

ANNIVERSARIES OF SCIENCE

Among the anniversaries of science listed by *Science Service* as "Today in Science" for the month of February we find the following:

Mme. Curie was elected a free associate member of the French Academy on February 7, 1922. She was the first woman so honored. We quote the following from a sketch of Madame Curie written for *Science Service* by Paul Appell, President of the Academy of Paris, in 1922:

At the close of the year 1906, Madame Curie was appointed a professor in the scientific department of the University of Paris. She continued her splendid work in a tiny laboratory—far too small—established in Rue Cuvier. Later, upon the University acquiring the land between Saint Jacques and Ulm Streets, a new street named for Pierre Curie was laid out through the length of this property, and a laboratory specially designed for the use of Madame Curie was started in coördination with the Pasteur Institute. The present arrangement is this: on one side is the special laboratory for Madame Curie's research work. On the other side is a wing belonging to the Pasteur Institute where researches are carried on in the application of radium and its emanation in the treatment of diseases, particularly those of a cancerous nature. Between these two buildings is a small structure containing the precious substance.....

At the present Madame Curie is devoting herself entirely to her work; to her scientific researches, to teaching, and to the organization of a radio-therapeutic service that she is conducting in collaboration with Dr. Regault of the Pasteur Institute.

On February 8, 1672, Isaac Newton reported to the Royal Society his discovery that "Light is composed of a heterogeneous mixture of

differently refrangible rays." Henry Andrews Bumstead in his "Physics in the Development of the Sciences" writes:

I must not neglect to mention also Newton's contributions to optics, which, while not of the fundamental importance of those we have just been discussing, were nevertheless worthy of their author. We need only to recall that he investigated the composition of white light, the colors of thin films, diffraction, and the possibilities of achromatism in refracting telescopes. He was not infallible; for he decided that it was impossible to make an achromatic refractor, and he supported the corpuscular theory of light against the undulatory theory of Huygens. In both cases, however, the evidence obtainable in his time strongly supported his position; and I think it was this, rather than the mere authority of his name, which caused the corpuscular theory to prevail during the following century.

Thomas A. Edison was born at Milan, Ohio, on February 11, 1847. M. Luckiesh in "A Popular History of American Invention" writes:

Edison came of plain people who were of the pioneer stock that built up the Middle West. At the age of eleven he was experimenting with chemicals in the cellar of his father's house. From many sources he had gathered together 200 large bottles, which he marked "Poison" to keep intruders from meddling with them. Then he filled them with mixtures and solutions of his own making, obtaining the materials from the village drug store. At the age of fifteen he was the possessor of important books on chemistry and physics and the owner of an apparatus for his experiments. So great a drain on his scant allowance were his experiments, that he persuaded his parents to permit him to become a train newsboy. By this time the Edisons had moved to Port Huron and the young inventor made the daily run from that town to Detroit, a distance of sixty-three miles, by the Grand Trunk Railroad. He carried his experimental apparatus with him, for in the baggage car he had a small laboratory and also a printing press.

From train boy he graduated into a telegraph operator and thus came in touch with the powerful force of which he was to become a master. By 1877, he was well established in a laboratory at Menlo Park, near Elizabethport, New Jersey, with sufficient capital to engage assistants and to work out one of the ambitions of his life, the subdivision of the electric current.

Arc-lights were clearly too big and dazzling for the home. What was wanted was a little lamp to which a comparatively small amount of current from a main conductor could be fed, just as small gas pipes tap large gas mains for home gas lighting. Contemporary scientists were quite sure that this could not be done and they were very solemn and profound when they learned of the unusual proposal of Edison. John Tyndall, one of the most eminent physicists of England, smiled when he read of the great task which the former train boy had set for himself, and in extenuation said that he would rather have Edison attack the problem than himself.

On February 18, 1564, Galileo Galilei, the great Italian physicist and astronomer, was born. In a letter to Kepler, 1597, Galileo wrote:

I esteem myself fortunate to have found so great an ally in the search for truth. It is truly lamentable that there are so few who strive for the true and are ready to turn away from wrong ways of philosophizing. But here is no place for bewailing the pitifulness of our times, instead of wishing you success in your splendid investigations.

I do this the more gladly, since I have been for many years an adherent of the Copernican theory. It explains to me the cause of many phenomena which under the generally accepted theory are quite unintelligible. I have collected many arguments for refuting the latter, but I do not venture to bring them to publication.

George Henry Corliss, who invented the Corliss engine, one of the outstanding steps in the development of the modern steam engine, died February 21, 1888. Decker and Kaempffert in "A Popular History of American Invention" write:

Corliss invented a valve that worked like a revolving door; a rotary valve. He used these revolving-door valves at each end of the cylinder, one to admit the steam and one to control the exhaust. A slight motion of one of these valves was sufficient to open or close the steam port or doorway almost without friction. To open and close his rotary valve, or revolving steam-door automatically, Corliss invented a governor which was apparently composed of "endless jimcracks, all precarious." By a system of parts, certainly more complicated than the simple ball-governor and sleeve of Watt, a weight was made to drop and suddenly cut off the steam as it entered the cylinder and not, as in the Watt engine, some moments later. . . . . Finding it difficult to convince business men that his engine was any better than Watt's, Corliss had to take risks in selling it. He knew his engine would save coal and therefore he adopted. . . . . the plan of installing an engine free of charge and of receiving in payment part of the money saved in coal. He sold one of his first engines with the understanding that he was to be paid all the money it saved in five years. At the end of the five years he had pocketed $19,734.22.

On February 23, 1843, Congress passed a bill appropriating $30,000 for the Morse telegraph. In a paper given at the International Exposition at Paris in 1868, Morse said:

Let me not be misunderstood as appropriating to myself the credit of the many modifications of the telegraph that have since been made in every part of the world, because I claim the invention of the generic telegraph. I do not pretend that the mechanism of the first forms of the telegraph was not rude, and even uncouth when compared with the beautiful workmanship of the European ateliers, of the hundreds of accomplished mechanicians who have brought to the work their incomparable ingenuity and skill. And yet I may appeal to the fact, generally acknowledged, that the essential features of the original invention have not been obliterated; they can be easily and distinctly traced through all the improvements made in the various parts, by which the different processes of the art have been more easily performed.

Johann Gutenberg, who invented printing with movable type, died February 24, 1468. H. G. Wells in his "The Outline of History" says:

The development of free discussion in Europe during this age of fermentation was enormously stimulated by the appearance of printed books. It was the introduction of paper from the East that made practicable the long latent method of printing. It is still difficult to assign the honor of priority in the use of the simple expedient of printing for multiplying books. It is a trivial question that has been preposterously debated.

W. R. W.

ABSTRACTS

Report on College Entrance Requirements. E. R. ENSLEY. *High Sch. Quart.*, **15**, 76–9 (Jan., 1927).—The author raises these two questions:

1. Do the colleges desire a continuance of a difference between the passing grade and the grade required for recommendation for college entrance?
2. Will the recommendation of the secondary school principal concerning the preparation (or the lack of it) for college entrance be considered by the colleges?

The requirements for entrance of Harvard University, West Point, colleges in the Southern Association, University of Pennsylvania and the University of Illinois are cited. "We believe that the commission on institutions of higher learning ought to warn, and, if necessary, bar from fully accredited membership, college members who knowingly admit freshmen who are not adequately prepared for college work."

J. H. G.

Submarine Insulation, with Special Reference to the Use of Rubber. R. R. WILLIAMS AND A. R. KEMP. *J. Franklin Inst.*, **203**, 35–61 (Jan., 1927).—There is nothing that can well replace gutta percha as an insulating material for submarine insulation. Soft vulcanized rubber can be made mechanically and electrically suitable for a period of a few years, but whether it will retain its suitability over decades is left to be demonstrated. The matter of absorption of water is of the greatest importance. Removal of water-soluble materials from the rubber lessens the tendency to absorb water. Hard rubber dust, silica and zinc oxide are the best fillers for rubber for submarine insulation.

J. H. G.

The Privileges of Learning. HUBERT WORK. *Gen. Mag. and Hist. Chron.*, **29**, 176–82 (Jan., 1927).—Every one past middle life develops a philosophy of life and has a desire to advise youth perhaps more than to warn them. Life is a series of mistakes. Few except the agricultural people learn to live alone. The legitimate field of the university is to impress upon the student the habit of learning instead of merely teaching him. Schools are essentials in our scheme of civilization.

University presidents are seeking to discover reasons for the failures of many of the educated. Applicants for registration are outnumbering class-room capacity. The privileges of learning should be raised to a high premium by processes of exclusion. With regards to the amount learned there seems to be a saturation point. Work has the greatest admiration for teachers. Much that they taught him has been forgotten, but they directed his life. College neither makes nor mars boys. It only speeds them on the way they have started. The home and the high school are way stations on the journey. Mankind is the appraiser of man's quality. Pride, or fear of defeat, often keeps students on their way to class honors. The young fellow who worked his way there may be the pride of the class at future reunions.

"Some seek an education for the love of it, but its prosaic purpose for most of us is that we may live the more comfortably. Education is an intangible possession; property exempt from levy or confiscation." Contact with others is imperative so that by ingrowing personality and introspection, a man is not left to himself in his old age. Everyone who has succeeded in the world has learned the value of five minutes. "Much of that taught me in the university has faded beyond recall but the strong men of the faculty have walked with me for a generation." J. H. G.

Light and Health. C. H. MAYO. *J. Franklin Inst.*, **203**, 1–10 (Jan., 1927).—In an address before the Institute, Mayo discusses the probable origin of the earth, the relation of our planetary system to other celestial systems, the light radiation from the sun and the subsequent accumulation of chemical energy stored for man's use. All matter is made of specific atomic structure of an electronic nature and this includes living matter. "Life, then, is more or less electric, and varyingly active, oxidative and chemical. Almost perfect acting cells are made chemically and resemble the living in some activities." Only lately has radiant energy been appreciated. Sunlight is broken by prisms into visible and invisible light. Beyond the red end of the spectrum we have the infra-red and beyond the violet, the ultra-violet rays. Certain wave lengths of the ultra-violet are most important in stimulating the chlorophyll, hemoglobin, and photosensitive plates.

The ultra-violet rays are readily transmitted by quartz glass. The mercury quartz lamp can be used in treatment of chronic diseases, especially tuberculosis of the lungs and joints. The ultra-violet of the sun is most effective at high noon and at high mountain altitudes, both conditions presenting thin layers of air. In plants, water and carbon dioxide are photosynthesized to formaldehyde and this is condensed to starch and sugar.

The first recorded use of light in medical treatment was by Russell, at Margate in 1715. Hematoporphyrin made from blood and injected into the blood of a Caucasian makes him sensitive to light and may cause death in sunlight. Phyloporphyrin, its vegetable counterpart, is in certain foods such as buckwheat. It causes local skin reactions in man and white-skinned animals when exposed to light.

Mayo makes reference to the writings of Shasted on vision. The amœbas are light sensitive cells; the microbic Euglena viridis has a mouth near which is a red spot sensitive to light and heat—the first eye. Certain worms have eyes in sockets. Later came lids and these first appeared in fishes. Very interesting facts follow on the eyes of birds and snakes, fish, flies and men. The third eye in the back of man's head is now but a vestigal structure, the pineal gland. Man's eyes are growing closer together; eventually both may rest in one socket. This may be a cause of argument in half a million years.

Regarding daylight saving, Mayo says, "Seventy per cent of the people of this country are now residents of the city and their needs should not be based on the working necessities of the thirty per cent of the farmers who are opposed to daylight saving. Those in the eastern portion more generally can be thankful to their officials who have put in daylight saving, making it possible for the children to receive more sunshine, and grown-ups a long evening and more contact with nature." J. H. G.

The Size of the Iodine Molecule. B. TOPLEY. *Nature*, **118**, 802–3 (Dec. 4, 1926).—E. Mack has calculated the cross section of the iodine molecule from the results of his experiments upon the diffusion of iodine in air; the result of the calculation is a value agreeing closely with the figure given by Rankine $(15.6 \times 10^{-6}$ cm.$)^2$. But the agreement would seem to be accidental and to arise from two circumstances, (1) Mack's experimental result for the diffusion coefficient is about 30 per cent too large, (2) the method employed to calculate the cross section is illegitimate. Arguments are given to substantiate these criticisms. H. K. M.

Complex Aromatic Hydrocarbons in Low-Temperature Tar. G. T. MORGAN AND D. D. PRATT. *Nature*, **118**, 805 (Dec. 4, 1926).—From a tar produced by distillation of coal, carbonized at 600°, a fraction boiling at 313–360° was obtained which yielded a complex mixture of aromatic hydrocarbons distinguished even in an impure state by their bright colors. Predominant among these hydrocarbons is beta-methylanthracene. H. K. M.

A Half-Century of Chemistry in America: 1876–1926. H. E. ARMSTRONG. *Nature*, **118**, 806–8 (Dec. 4, 1926).—A delightful critical review of the accomplishments of the American Chemical Society called forth by the "golden jubilee number." H. K. M.

The Occurrence of Helium and Neon in Vacuum Tubes. R. W. LAWSON. *Nature*, **118**, 838–9 (Dec. 11, 1926).—The occurrence of helium and neon in vacuum tubes has been observed many times by different investigators since the paper of Collie, Patterson, and Masson in 1915. The results have been interpreted as due to a disintegration by the electric discharge of the nitrogen atom. Whatever may be the true interpretation of these experiments, their importance cannot be denied, for they undoubtedly reveal a phenomenon in electric discharge work, the significance of which has not hitherto been adequately appreciated. There can be no doubt that the results cannot be interpreted as arising from a simple air leak, for positive results have been obtained under a great variety of conditions and elaborate precautions have been taken to avoid contamination from outside. Nevertheless the possibilities of the diffusion of atmospheric helium and neon through the walls of the apparatus first suggested by Lo Surdo in 1921 does not seem to have received the attention it deserves and the author of the note indicates that the effect is by no means negligible. H. K. M.

The Synthesis and Disintegration of Atoms as Revealed by the Photography of Wilson Cloud Tracks. W. D. HARKINS AND H. A. SHADDUCK. *Nature*, **118**, 875–6 (Dec. 18, 1926).—The examination of 27,000 tracks of 8.6 cm. range shows two cases in which an alpha particle attached itself to a nitrogen nucleus. One of the protons was emitted in a forward direction, that is, with a component of velocity in the same direction as that of the alpha particle, while in the other case the proton was emitted backward. Blackett at Cambridge has observed eight similar events. The smallest velocity of the alpha particle which has thus far been sufficient to disintegrate a nitrogen atom corresponds to a remaining range at 15° of about 6.2 cm. The range of alpha particles from polonium which was used in practically all of the early work on alpha-ray tracks is only 3.925 cm. H. K. M.

The Cavendish Laboratory as a Factor in a Counter Revolution. N. SHAW. *Nature*, **118**, 885–7 (Dec. 18, 1926).—Parliament in its wisdom has once more made the University of Cambridge responsible for the teaching of its students, the wheel has come

round a full circle and the author indulges in a retrospect of the teaching of science.

H. K. M.

Retrospect. J. J. THOMSON. Supplement to *Nature*, **118,** 41–4(Dec. 18, 1926).
James Clerk Maxwell. J. LARMOR. Supplement to *Nature*, **118,** 44–7 (Dec. 18, 1926).
Lord Rayleigh. A. SCHUSTER. Supplement to *Nature*, **118,** 47–9 (Dec. 18, 1926).
J. J. Thomson. O. LODGE. Supplement to *Nature*, **118,** 49–51 (Dec. 18, 1926).
E. Rutherford. N. BOHR. Supplement to *Nature*, **118,** 51–2 (Dec. 18, 1926).
The Cavendish Laboratory 1876–1900. R. GLAZEBROOK. Supplement to *Nature*, **118,** 52–8 (Dec. 18, 1926).
Research Work in the Cavendish Laboratory in 1900–1918. J. A. CROWTHER. Supplement to *Nature*, **118,** 58–60 (Dec. 18, 1926).

The above articles taken together give the history and achievements of the Cavendish Laboratory and will be of interest to teachers of chemistry as well as of physics.

H. K. M.

Ion Visits the Realm of Air. J. A. SHELTON. *Sch. Sci. and Math.*, **26,** 960–5 (Dec., 1926).—A brief playlet of chemical nature with the following cast:

1. Ion—A Wanderer, Looking for "A MAN."
2. Chemist—Interested in Affairs, Welfare, and Understanding of Man.
3. Health—A Spokesman for Oxygen, Active, Energetic.
4. Nitrogen—The Wise Conservative Councilor.
5. Water Vapor—The Governess.
6. Carbon Dioxide—A Builder of Plant Tissues.
7. Argon
8. Helium
9. Neon
10. Krypton
11. Xenon

Silent Characters, Inert, Useless, Rare.

B. H. B.

Radium and the Ray-Gentor. H. H. BARKER. *Sch. Sci. and Math.*, **26,** 974–80 (Dec., 1926).—An illustrated article describing the Ray-Gentor, a device designed to render a number of remarkable facts concerning radium visible to the student. Device consists of a lead-lined container holding the radium salt and equipped with screens of mica and lead so that by proper choice operator can obtain:

(*a*) Alpha, Beta, and Gamma Rays together.
(*b*) Beta and Gamma Rays together.
(*c*) Gamma Rays only.

A list of demonstration experiments is appended under following headings:

1. Ionization.
2. Photographic Plates.
3. Phosphorescent Zinc Sulfide.
4. Willemite.
5. Barium and Lithium Platinocyanide.
6. Range of Alpha Rays.
7. Electro Magnet.
8. Electroscopes.

B. H. B.

The Social Aspect of College Entrance Restrictions. BENJAMIN DEUTSCH. *Educ.*, **47,** 272–80 (Jan., 1927).—It is a narrow view which holds either that the only aim of the college is to nurture learning or that the increasing demand for college education merely offers opportunity for raising scholastic standards by eliminating all but those who have the scholarly instinct developed to a marked degree.

If higher education fosters only pure learning and the professions, there is left for the less intelligent the leadership in politics and other human affairs.

An industrial age, such as ours is and shall continue to be, fosters the less intelligent who are content to spend their lives in performing extremely simple mechanical tasks requiring minimum intelligence. The intelligent always tend to die off. The survivors of such artificial conditions are the less intelligent.

Careful study indicates that best results will be obtained only when colleges are equipped to function for greater understanding and sympathy with human affairs and when they welcome the greatest possible number of those who can comply with the

minimum requirements with the idea in mind that those whose intelligence is sufficient to bring them to the college gates are thereby shown to be able to exercise leadership in a crowd regardless of whether or not they go to college.

Tuition should be on the cost plus basis. Preference should be shown local students.

Education, like all activities of modern life, derives distinct advantage from mass production. O. J. S.

The Natural System of the Elements from the Modern Viewpoint. ERICH THILO. *Naturw. Monatsh. biol. chem. geograph. geol. Unterricht*, **24**, 8–36 (1926).—(1) The ordinal number of the elements can be taken as the atom kernel charge number and T.'s new system of elements is derived by arranging the elements in the order of their smaller atom charge numbers. In addition from T.'s theory each element can be singled out without reference to others and its place in the system shown. (2) The isotope idea explains the non-integralness of the combined weights on which grounds in the three element pairs Ar–K, Co–Ni, and Te–I, the one with the lesser atom kernel charge number has the smaller combined weight. (3) Generic relation between elements is shown from radio-activity. (4) Accurate idea of the construction of the electron shells of the atoms gives the explanation for the periodic change of valence. The length of the periods may also be calculated in advance. R. E. P.

Chemical Training a Business Asset. EDITORIAL. *Chem. Bull.*, **14**, 12–3 (Jan., 1927).—The writer tells of two business firms—neither of which are to be classed as chemical firms—which recommend chemists for executive positions in other departments as well as in their own technical department. In the first case the official gave three reasons for such an attitude. He believed that a man who studied chemical engineering was assured an opportunity to develop (1) a breadth of view, (2) an ability for the observation of details, and (3) a familiarity with the manipulation of delicate apparatus offered by no other engineering course. In the second case, the president of the concern made the following statement when discussing the need of taking on another high-class man. "Well, go out and get another chemist. They have not fallen down on us yet." The writer also states that a chemist is prone to attack a problem with a more open mind than the non-chemist and that his evaluation of experimental data is apt to be more critical and somewhat broader than that of the other fellow. E. L. M.

Would Graduate Many Sophomores to Make Room for "Real Students." ANON. *School*, **38**, 320 (Jan. 6, 1927).—A suggestion that one-half of the students in American colleges be graduated at the end of the sophomore year with the degree of Associate in Arts, thereby leaving the last two years of study to "real students" was advanced recently by Frederick C. Ferry, president of Hamilton College, who was one of the speakers of the sesqui-centennial dinner of Phi Beta Kappa. Dr. Ferry added that if all who held the Associate degree under such a system were eligible to join a university club the novel conception might be made real without difficulty. Dr. Ferry went on to tell of the attitudes held by Europeans and other foreigners and their criticism of our colleges and life. E. L. M.

College Entrance Examination Board. ANON. *Bull. Am. Assoc. Univ. Prof.*, **12**, 560–2 (Dec., 1926).—Scholastic aptitude tests may or may not measure "general intelligence" or "general ability" but high scores in tests do indicate an ability to do a high order of scholastic work, says the report.

"It should be remembered that perfect prediction of academic attainment is impossible because of (1) technical difficulties of measurement of academic performance in separate courses, (2) variation in the motivation of students toward doing work in keeping with their ability, and (3) the total effect of unmeasured factors such as physical conditions, emotional stability, interest, attitude, etc., which make or mar an academic career." Boards of admission are not confronted with the problem of perfect prediction but with the problem of devising a method which gives best possible predictions. The report gives some statistics on scholastic aptitude tests. E. L. M.

Joseph Priestley on Liberal Education. EDGAR F. SMITH. *Bull. Am. Assoc. Univ. Prof.*, **12**, 576–7 (Dec., 1926).—The author gives a few abstracts from an essay by Joseph Priestley in which Priestley suggests that other courses might be introduced along with the courses adapted to the learned professions as "the far greater part of the students were young gentlemen designed for civil and active life." Civil history, civil policy, constitution, and laws were some of his recommended studies.

The author asks if these suggestions are modern in tone and if our schools of finance and commerce and administration are not products of these visions of Joseph Priestley upon a "liberal education." E. L. M.

The Discovery of Anesthesia. C. A. H. SMITH. *Sci. Monthly*, **24**, 64–70 (Jan., 1927).—Although ether had been known for a long time it was not until 1846 that its value as an anesthetic was demonstrated. Until then surgery was without anesthesia. In 1844 Horace Wells noticed that nitrous oxide produced immunity from physical pain and in 1845, after considerable experimenting on his own patients, he gave a demonstration in Boston before a class of medical students, but the demonstration failed and he was discredited. Wells' assistant in the experiment, W. T. G. Morton, a student in Harvard medical school and practicing dentist, was studying the properties of ether and experimenting with it on small animals and on himself. On Sept. 30, 1846, he used it successfully on one of his patients for extracting a tooth. He then arranged for a demonstration before a representative gathering of surgeons on Oct. 16, 1846. The demonstration was entirely successful and he was called upon to administer ether for many cases. Opposition soon arose, however, and efforts from all quarters were made to discredit Morton. Although he succeeded where others failed, he reaped a whirlwind of abuses that was the most humiliating ever visited on a great pioneer. G. W. S.

A Brief Review of the Fuel Field. S. W. PARR. *Ind. Eng. Chem.*, **19**, 7–8 (Jan., 1927).—The first published research on fuels appeared in 1826, so that the progress of scientific fuel utilization may be said to cover 100 years. P. says that the past century has been devoted by coal experts to getting the maximum heating value out of coal, while the coming one must witness the more efficient utilization of the numerous raw materials for chemical manufacture, which reside in coal. This number of the periodical contains the latest summaries of the branches of coal chemistry, including "high" and "low" temperature coke, tar, oils, and gas. V. R. T.

A Constant Level Water-Bath Using Distilled Water. R. C. GERDEL. *Ind. Eng. Chem.*, **19**, 50 (Jan., 1927).—Constant level baths fed with tap water are likely to acquire a coating of scale precipitated from the water. A method is given, with diagrams, involving the usual constant level principle, for employing distilled water in a bottle, removed a considerable distance from the bath. V. R. T.

"Acrolite"—A New Synthetic Resin. JAMES MACINTOSH. *Ind. Eng. Chem.*, **19**, 111 (Jan., 1927).—Combination of phenol and glycerol, in the presence of a small amount of sulfuric acid, at a temperature of about 170 degrees Centigrade, which causes water formed to distill off, results in a synthetic resin which has all the desirable properties of the formaldehyde-phenol products of the type of "Bakelite." The resin appears first as a watery liquid, and changes progressively to a dark rubbery mass, fusible and soluble in alcohol, which is further altered by heat and pressure to an insoluble, infusible, black solid, which can be sawed and drilled. This progressive change of properties characterizes a commercially useful resin. V. R. T.

The Transformation of Coal into Oil by Means of Hydrogenation. DR. FRIEDERICH BERGIUS. *Can. Chem. & Met.*, **10**, 275 (Dec., 1926).—In ordinary bituminous coal the ratio of carbon to hydrogen is 16 to 1, while in a liquid oil it is about 8 to 1, so that in converting coal into oil the hydrogen content must be doubled. On this basis a method of converting coal into oil has been developed. Bituminous coal is ground into particles of 2 mm. diameter or less and is mixed with the heavy oil of a previous run to form a thick, pasty mass. It is pumped into the reaction chamber and hydrogen is forced in under pressure. The reaction proceeds best at a pressure of 2200 to 3000 lbs. per square inch. After several hours' treatment at 300–350°C., the material is transformed into a pitch-like material. If heated to 420°C. the larger molecules are cracked and it becomes liquid.

The products are different from those obtained from high- or low-temperature distillation. One thousand kilos gave 150 kilos gasoline, 200 kilos of a middle grade oil, 60 kilos lubricating oil, and 80 kilos of fuel oil. The gasoline is high in aromatic hydrocarbons which serve as antiknock materials.

All types of bituminous coals are reported as suitable for hydrogenation, but real anthracites cannot be hydrogenated. Two experimental units having a total capacity of 4 tons per day are in operation. Two large plants with an expected capacity of 1,000,000 barrels of various oily fractions per year are at present under construction in Germany.

In the United States with her large supply of crude oil the hydrogenation of coal itself might appear of scientific interest only. The powdered coal can be mixed with the coal tar from the coke ovens, and in the process of hydrogenation and cracking converted into more valuable products. About 15–20 per cent of the coal used in the hydrogenation process is converted into methane and ethane, so that the process could be regarded as a highly improved gas plant, since the gas produced has the same heat value, while the oil produced is worth much more than the coke of the ordinary plant.

D. C. L.

The Semi-Centenary of Willard Gibbs' Phase Law, 1876–1926. ERNST COHEN. *Science*, **64**, 621 (Dec. 24, 1926).—A Jubilee issue of the *Chemisch Weekblad* (Sept. 18, 1926) has been devoted to the semi-centenary of Willard Gibbs' phase law. G. H. W.

Publication by Photographic Reproduction of Typewriting. SEBASTIAN ALBRICHT. *Science*, **64**, 650 (Dec. 31, 1926).—In Volumes IV and V of the *Transactions* of the Astronomical Observatory of Yale University, recently published, very extensive use was made of a photographic reproduction of typewriting. The cost of composition, paper, and running off was about one-third that of printing with lead type. One complete proof-reading was eliminated and greater accuracy attained without sacrifice of legibility.

Suggestions are offered toward adopting the method for general use in publishing scientific papers. G. H. W.

The Chemistry of the Future. H. P. CADY. *Science*, **65**, 1–4 (Jan. 7, 1927).—Speculations as to the discovery of new facts and laws and the modification of present theories in the next fifty years. G. H. W.

Humanizing War. GEORGE WITTEN. *Outlook*, **144**, 529–31 (Dec. 22, 1926).—Defense of gas warfare by a man who was both gassed and wounded. G. H. W.

Chemical Warfare Is Here to Stay. J. M. MATTHEWS. *Gen. Sci. Quart.*, **11**, 127–31 (Jan., 1927).—Remarks made at Williamstown and other places by American chemists in support of chemical warfare, as opposed to popular propaganda against it on the basis of its being abhorrent and inhuman, are all very interesting and truthful but, unfortunately, they are entirely beside the real point at issue. It is not because it is more inhuman but because it can more readily and completely overcome the enemy. National prestige will not be a matter of what nation can put tremendous armies in the field, but which one is cleverest in devising and manufacturing and using chemical agencies in war. Note how useful gas is now in the hands of the police. A good dose of gas will take the fight and spirit out of the most unruly mob and will not permanently disable anybody. An article in *Le Matin* tries to picture Paris attacked by a fleet of 100 airplanes and a bombardment and drenching by gas; but the citizens could escape to less infected areas and then compare the few casualties brought about in this manner with what would be the case if the bombardment were of high explosives. History teaches that War Departments are characterized by remarkable stolidity. The introduction of shot and shell was opposed as being less humane than killing with sword and mace, etc. If people are accustomed to being killed in one fashion, they oppose innovations in killing. The old physicists who formulated the laws of motion and studied the resistance to change as manifested by the heavenly and earthly bodies, never studied the inertia of a War Department toward any change of method. If chemical warfare is more effective in its purpose, it will certainly be employed in the next great war, whenever that may take place. It will be utterly futile to try to head it off. These bizarre notions about forbidding or restricting chemical warfare by international agreements through the League of Nations or through any other international medium are doomed to failure in case occasion ever demands their actual application. Picric acid and TNT are just as much chemicals as charges for explosive shells, as mustard gas or other so-called chemical warfare materials. J. H. G.

Motion Pictures in the Teaching of Junior High-School Science. J. T. SHRINER. *Gen. Sci. Quart.*, **11**, 40–7 (Nov., 1926).—Because some pupils are eye-minded and must see the process by picture or the actuality, and since, to quote Caldwell, "The rate and quality of learning are improved by an increase in the number of the senses used," there is justification for using motion pictures as visual aids in the teaching of junior high-school science. But the motion picture and the schedule for the school should be carefully chosen; the teacher carefully prepared on the film and the lesson and pictures should be censored before being used. One group of pupil censors the author calls the "Once Overs," a second group the "Spotters," and a third group should be comprised of teachers of the subjects in which the films are assigned. Motion-picture use in the public school has been retarded by the type of picture used and the manner of presentation. A poor film lesson is worse than one without the film. A film should arouse the pupil's curiosity, hold his interest, and guide his observation into the working out of life situations. The story of the gasoline engine is used as an illustration. Motion pictures should enrich the class-room activities. Here they have their limitations, however. Some pupils will be inspired to continue the projects presented by motion pictures, in life situations. J. H. G.

The Science Teacher. W. G. WHITMAN. *Gen. Sci. Quart.*, **11**, 47–50 (Nov., 1926).—Many normal school and university pupils will eventually teach science. The author says that the prospective science teacher should make a critical analysis of

himself by asking the following questions: Are you very much interested in science? Are you skilful in experimental work? Have you ability in devising experiments from limited equipment? Are you willing to spend much time outside of teaching periods in preparation of laboratory and demonstration work? In your required science work in the university or normal school have you been graded in the upper half of your class? Have you a personality that would help to make you a successful teacher? The subject-matter preparation for general science teaching and chemistry teaching is then given in detail. Just as with medicine, teaching should be considered a profession and be given professional training. Study Kilpatrick's "Foundations of Method." General educational courses, courses in psychology and methods of teaching, and specific science training courses should be taken. "There is a large civic responsibility upon the teacher of science, because science has within itself the potential elements of remaking one's environment. Science is a messenger of truth and imposes obligations upon everyone who elects to teach it." J. H. G.

Available Motion-Picture Films. *Gen. Sci. Quart.*, **11**, 56–9 (Nov., 1926)—A complete list of films, with information on the method of distributing them, is given in *Miscellaneous Circular* **27**, which may be obtained on application to the U. S. Department of Agriculture at Washington, D. C. J. H. G.

Objectives as Determining Factors for Making a Course of Study in Junior High-School Science. Z. BARBER. *Gen. Sci. Quart.*, **11**, 1–12 (Nov., 1926); 79–94 (Jan., 1927).—In discussing what the objectives of the subject are, the author quotes the publication in 1920 of the report of the Committee for the Reorganization of Science for Secondary Schools (Otis Caldwell, Holland R. Sperry, W. L. Eikenberry, H. C. Hines). "From these quotations it is clear that the kind of science courses that are needed for the junior high schools are very different from the usual courses in botany, biology, physics, or chemistry, and are by no means to be made up merely of parts of these sciences adapted to the mind of the junior high-school pupil." Thirty-one aims of science teaching are quoted from various sources. Much overlapping is acknowledged in these. Mr. J. M. Glass is quoted at much length from his "Curriculum Practices in the Junior High School and in Grades Five and Six." The author states, "Lack of suitable text-books has kept many schools from including science. Were it possible to obtain teachers specially trained for the junior high-school science, this would not be so large a factor, but at present few institutions are offering special training to teachers for this work, and without well developed courses of study and suitable text-books it has seemed unwise to introduce the subject."

In the second paper, the author illustrates the exact content of courses being offered in various schools by an examination of the following: 7th grade work in Ben Bluett Junior High School, St. Louis; 7th grade, New York; 8th and 9th grades, Rochester, N. Y.; 7th and 8th grades, Berkeley, Calif.; 7th, 8th, and 9th grades, Oakland, Calif. An article by Dr. Bailey in the *University High-School Journal* for October, 1921, is quoted.

The Department of Superintendence Yearbook, N. E. A. (1924), together with the works of Charters, Hines, Bobbitt, and Bonser, form the basis for the following review of the subject by the author: The Questions to Be Considered, Organization of the Course of Study-Making Group, and Steps in Procedure.

Making the Course of Study; the Questions to Be Considered: (*a*) Whom does the curriculum concern? (*b*) What are the aims and objectives of education? (*c*) What are the purposes of the course of study? (*d*) What are the essentials of a course of study? (*e*) Who shall make the course of study and how?

Organization of the Course of Study-Making Group: Investigate the practices in other cities, *i. e.*, the President of the Chicago Principals Club appointed a committee; the committee should be composed of science teachers, the supervisor of science instruction to be included, but the entire procedure to be in the hands of an expert in curriculum construction. There should be familiarity with the works of Bobbitt and Charters.

Steps in Procedure: (*a*) Subject-matter analysis; (*b*) activity analysis; (*c*) functional analysis; (*d*) project curricula; (*e*) summary of steps. J. H. G.

College and the Exceptional Man. BERNARD DEVOTO. *Harper's*, **154**, 253 (Jan., 1927).—Exceptional students are those of intelligence clearly superior to that average to the accommodation of which the college machinery is geared. Early in his career every teacher must decide what his attitude toward them is to be.

These students leave college convinced that much of their youth has been wasted in the pursuit of respectable but counterfeit education, and the feeling that the college has not lived up to the contract it assumed when they entered it. Examples of experiences with students are given.

A young lady found the accepted idea among undergraduates to be that classes existed solely to provide a background for activities. So she went in for activities until her sophomore year when a course in 18th century literature started her thinking about questions of considerable importance. She spent nearly two years in a faithful effort to find professors or courses that would cast some light on these questions and concluded there were none. She decided to spend a year away from college, thinking over what she had learned and being able to spend at least as much time as before learning new things.

A young man who had graduated as chemistry major and found his work stimulating came back for graduate work only to find that the natural sciences habitually plunged farther into the unverifiable than the economics Prof. at his wildest. So he gave up his formal work, but still "stuck around" using the library and going to theaters, concerts, etc. Delivered from contact with professors and classes he found himself more stimulated than ever before. The road that took him to college had proved to lead him past and directly away from it.

Author concludes that the superior student has no place in the college of today, that his best educational interests lie elsewhere, that he is gravely and sometimes irreparably hampered in the system now current, that he will most wisely altogether abandon it. In place he suggests theaters, concert halls, opera houses, museums of all kinds, and libraries. With his famished hunger, healthy skepticism, and deadly curiosity to guide him through these storehouses of knowledge he will in the end be educated.

J. W. H.

Oxygen in the Rôle of Nurse. ANON. *Chemicals*, **27**, 17 (Jan. 17, 1927).—Increased concentrations of oxygen have been proved to be of great value in treating pneumonia, but the methods used caused the patient considerable discomfort. A new oxygen chamber devised by Dr. Barach does not inconvenience or cause the patient any discomfort. The temperature is controlled to suit the patient's wishes. Moisture and CO_2 are removed as the air-oxygen mixture circulates, the former by means of a cold tube and the latter by trays of soda-lime. No motor or electrical equipment is necessary.

C. R. KINNEY

The Fine Arts in Liberal Education. G. L. OMWAKE. *Sch. and Soc.*, **24**, 720–3 (Dec. 11, 1926).—Education in America has been of a practical nature and the good and the true have received attention in the educational plan but the appreciation of the beautiful has been neglected. America's pioneering days are over and she should now turn her attention to a consideration of the arts, for even the average person has the ability to appreciate the beautiful if this ability be but trained. A program of art instruction in our schools is much needed and even a survey course covering the fine arts field would be a good beginning. Carnegie Foundation in New York is providing collections of reproductions of great paintings for use in colleges and the Presser Foundation of Philadelphia is providing scholarships and buildings for the promotion of musical art in institutions of liberal learning.

Along with inculcating ideas of thrift in the youth of the land, the college should teach spiritual values as well, in order that its students may be prepared to live a well-rounded life. To do this the college "must present with equal emphasis the entities that make up that noble trinity of divine and human ends—the true, the beautiful, the good."

K. S. H.

Adequate Education for 20th Century Democracy. R. T. HARGREAVES. *Sch. and Soc.*, **24**, 717–20 (Dec. 11, 1926).—During the 19th century American educators devoted their time and energy to the study of the child and great strides were made in improving educational and living conditions. It was felt that a child between the ages of 6 and 14 should attend school. The 20th century educators are devoting themselves to a study of adolescents and the age of school attendance has been pushed to 16 years. There is now hope for universal state laws compelling this and still further hope for continuation schools up to the age of 18. The junior high school and the junior college represent two phases of the attempt to understand adolescent youth and to aid him in his adjustment to his environment.

America was the first nation to aim at universal education for all her children regardless of their economic station. This, however, led to a standardization of method and technic that neglected to consider individual differences. We must now aim to adjust the educational system so that individualism will not be killed, and here more than ever must we rely on the personnel of the teaching staff. Coupled with the educational research we must have teachers who realize "the imperative necessity of recognizing and cultivating the variability and flair of the individual child and of extending the range and intensity of his life... that the oncoming generation may live a broader, saner, sounder, more rational and intelligent life."

K. S. H.

Charles William Eliot. Committee (L. B. R. BRIGGS, GEORGE PALMER, GEORGE F. MOORE, FRANK W. TAUSSIG, THEODORE W. RICHARDS). *Sch. and Soc.*, **24**, 695–7 (Dec. 4, 1926).—The Committee speaks of the appointment of Dr. Eliot as president of Harvard as having broken more than one tradition. He was young, a chemist, not popular and not widely known. His habit of expressing his own opinion got him into many a controversy. As a teacher, in which capacity he served for many years, he gained no peculiar distinction. He had been a tutor at Harvard, teaching mathematics, had been assistant professor of mathematics and chemistry in the Lawrence Scientific School, had been professor of analytical chemistry at M. I. T., had written for the *Atlantic Monthly* and with Prof. Storer had produced two text-books in chemistry.

His nearsightedness made immediate recognition ofttimes difficult and this failure to recognize students in the college yard caused much criticism. Nevertheless his knowledge of individual students was amazing and his sympathy and admiration for one who worked against great odds to gain an education were never lacking. He was keen to perceive the faults of others yet always willing to overlook them. If irritating remarks were made to or about him in faculty meetings, he accepted them, the committee states, as part of that give-and-take relation which he strove to maintain. He was easy to approach and possessed a remarkable power of listening, always eager to know the opinion of other men.

Dr. Eliot was instrumental in transforming the college into a university and also in creating graduate schools. He was an able speaker and to the end threw all his strength into work for the public good. K. S. H.

The Greatest Waste in Education. B. R. BUCKINGHAM. *Sch. and Soc.*, **24**, 653–8 (Nov. 27, 1926).—This article is a plea for the continuation of the studies of childhood because they represent the race at its highest level of thought and achievement. From childhood up everything seems to be for the young, even in colleges and universities where the curriculum is constantly under fire, always being remodeled for the better.

The product of the school, the author states, is changed human beings. The students comprise the raw material, and after being processed by the curriculum, should be able to cope with their environment and meet squarely the problems of every-day life. The expense in the public schools is comparable to that in industry where, unless the proper precautions are taken as to storage, etc., the products immediately begin to deteriorate. Society, unfortunately, takes no precautions to prevent this deterioration, hence the greatest waste of time, money, and energy is not due to what goes on inside the college or university, but rather what happens to the student after he has been graduated. And because the student is permitted to forget most of that which he has learned, the author calls this—the greatest waste in education. The student pays for something he immediately loses and so society is cheated of its returns. This may be the result of an attempt on the part of the universities to cover the field of human knowledge, a student merely sampling the endless choice placed before him. If we look at the English boy of a few generations ago, we find that his time was spent on one or two subjects and rarely did he ever give up the study of the classics.

But, the author says, "All the offerings of the school are of some value. Consider at what small cost, after the first cost has been met, they may be kept. If no day passes—even no week or month—without some renewal of your early acquaintance with English literature, economics, philosophy, or science, do you doubt that you will be a better man?" K. S. H.

The Contribution of Slides and Films to Science Teaching. L. P. MILLER. *Gen. Sci. Quart.*, **11**, 13–7 (Nov., 1926).—The author urges care and discrimination in the selection and use of slides and films with a primary end in view, not for entertainment, but to dramatize text-book topics. Still and motion pictures are used in four distinct ways: (1) In the class-room; (2) the school assembly; (3) the public assembly; (4) selected groups of classes in the school auditorium. The author speaks of an audience of 1500 which enjoyed illustrated lectures given at the Scranton Central High School. The scheme for taking groups of classes into the auditorium has proved most successful. Thus, chemistry classes report for chemistry topics.

Pictures are purchased by the school, borrowed, or obtained as a loan by paying the expressage. The state law offers the greatest barrier to the use of films as motion pictures. No teacher should attempt to show pictures of any kind without having first seen them himself. A comprehensive list of free pictures should be available to all teachers. Films should be scheduled in advance by teachers; there should be budgets to cover cost of visual education; there should be larger state appropriations to the Philadelphia Museum and the State Museum for the use of distributing slides and

films; the production of non-inflammable films should be urged; a committee should be set to work at once on problems involved in the use of slides and films for educational purposes. J. H. G.

The Pronunciation and Spelling of Words Used in Science. D. ROLLER. *Gen. Sci. Quart.*, **11**, 18–28 (Nov., 1926).—Teach the proper pronunciation of scientific terms when the student first encounters them. The method of oral example and imitation has no superior in accomplishing this. "The majority of us recognize that there is a normal pronunciation and we fondly believe that we conform to it," says Brander Matthews in his essay on "A Standard of Spoken English." Jos. Thomas says, relative to pronouncing proper names, "....to pronounce modern names as nearly as possible as they are pronounced by the inhabitants of the respective countries to which such names belong...." The author then enumerates common mistakes in pronunciation and follows up by listing five pages of mispronounced scientific words giving their correct pronunciation. Two pages of scientific words which have yielded to simplified spelling conclude the article. J. H. G.

The Ear Marks of a Good Science Teacher. E. R. DOWNING. *Gen. Sci. Quart.*, **11**, 34–9 (Nov., 1926).—The author lists and elaborates upon six essential qualifications for a good science teacher. Besides these, he must have certain character and personal qualifications, some of which are his heritage, while others come from courses of study. He should have had a good broad foundation in astronomy, geology, physics, chemistry, biology, and particularly ecology. He must have read widely. He should be a member of some association of his progressive fellows and must be a constant reader of some journal devoted to science and science pedagogy. The author says this condition is met by members of the Central Association of Science and Mathematics Teachers. The author sent out to them 300 letters and got 104 replies to certain statistical questions relative to training and reading of science teachers. Three pages of statistical returns from this questionnaire conclude the article. J. H. G.

Prediction of Teaching Success. I. N. MADSEN. *Educ. Admin. and Superv.*, **13**, 39–47 (Jan., 1927).—A resumé of a study made to determine why certain teachers had failed. The chief reasons were found to be: (1) Poor knowledge of subject-matter. (2) Lack of instructional skill. (3) Poor discipline. (4) Inability to systematize work. (5) Inability to coöperate. (6) Indiscreet conduct. (7) Lack of enthusiasm. (8) Personal appearance. (9) Lack of energy. The author comes to the conclusion that the most promising measures of predicting teaching success are: (1) Reliable and valid measures of general intelligence. (2) Measures of proficiency in previous school career, particularly in elementary school subjects. (3) Measure of achievement in normal school. S. R. P.

The Origin and Development of the High School in Ohio. WILLIAM DANIEL OVERMAN. *Ohio Teacher*, **47**, 102–4 (Nov., 1926).—A continuation of an article which began in the October (1926) number of *The Ohio Teacher*. A splendid summary of the origin and development of high schools in Ohio, showing how the term originated, its connection with the academy movement, and how the present public high school became organized as a separate institution. S. R. P.

Major Issues in School Finance. ANON. *Res. Bull. N. E. A.*, **5**, 1–64 (Jan., 1927).—The major issues in school finance are revealed through a study of school costs and economic resources of the various states together with the situation in individual states. State advance toward sound school finance programs, together with present weak spots in state systems of school finance, are indicated. A suggested plan of state and local taxation, which is essentially sound, is formulated. S. R. P.

Coaching for Mental Tests. CURTIS MERRIMAN. *Educ. Admin. and Superv.*, **13**, 59–64 (Jan., 1927).—An experiment was performed at the University of Wisconsin during the year 1924–25 with 105 students in a course of educational psychology to determine if coaching for mental tests had any effect upon mental test scores. The 105 students were divided into four groups—two control groups and two experimental groups. The Thorndike College Entrance Examination was used. The experimental group spent six hours of intensive study, receiving instructions in finding the most advantageous ways of doing certain parts of the tests, in classifying the types of questions and in answering specific subject-matter questions. They were told the entire plan and purpose of the experiment and cautioned not to reveal any of the plan to members of the control group. The control group was not told anything about the experiment. There was a positive gain from coaching which is in agreement with the findings of Graves, Bishop, and Glick. There was a positive effect upon student placement; about half of the experimental group improved their placement, advancing from weak or average to average or strong. No attempt was made to determine whether the gains were permanent. S. R. P.

Individual Laboratory Work versus Teacher Demonstration. E. R. DOWNING. *Gen. Sci. Quart.*, **11**, 96–9 (Jan., 1927).—A presentation of the results of eleven experimental studies on this problem. Individual laboratory work has appeared historically as follows: Liebig's laboratory opened at Giessen in 1824; the professor of chemistry in the medical school of the University of Pennsylvania opened his laboratory to promising students in 1836; about the middle of the 19th century, Agassiz' laboratory in an old boat house on the Charles River (Lawrence Scientific School, later incorporated in Harvard University) was opened to students to work on research problems; Pickering opened a laboratory in physics at M. I. T. in 1868. In answer to a U. S. Bureau of Education bulletin questionnaire in 1880, only four schools of the 600 which replied were giving a laboratory course in physics. In 1886, in response to a requirement of Harvard University, secondary schools began to open laboratories in physics. Science was taught by book, then demonstration, then laboratory method. Judging by scientific attainments, demonstration methods were reasonably successful.

Seven experiments, made by different students at the University of Chicago, have confirmed findings of the first one, that the demonstration method is superior in immediate tests, and only slightly inferior in delayed tests. For details of the experiments so far published, see *School Review*, **32**, 688–97 (Nov., 1925).

Experiments show that on immediate tests, the information has been acquired by the student quite as well by the demonstration method as by the individual laboratory method. On delayed tests, the laboratory method makes a better showing. Some investigations show that even laboratory skills, at least in the initial stages, are better acquired by demonstration work.

There is a saving of time by demonstration method up to 50 per cent. There is an indication of a saving in actual current costs of laboratory material of $^{15}/_{16}$ in favor of demonstration method.

It is interesting to note that in European secondary schools, science is taught, as a rule, by the demonstration method. J. H. G.

Robert A. Millikan, Physicist. ANON. *Gen. Sci. Quart.*, **11**, 109–12 (Jan., 1927).—Ideas suggested by Chapter XXIII of E. L. Smith's "Everyday Science Projects," in which directions for making kites and gliders mentioned in connection with Millikan's experiments, are given. R. A. Millikan is known as Director of the Norman Bridge Laboratory at California Institute of Technology; winner of Nobel Prize, 1923; co-author of "Practical Physics" and "Elements of Physics;" and for his researches on the cosmic ray, begun in 1915, which were interrupted by war service but resumed in 1923. Kelley Field, Pike's Peak, Muir Lake (Mt. Whitney), Lake Arrowhead (San Bernardino Mts.), Andes Mts., have been the scenes of his experiments on cosmic rays.

In the Terry Foundation lecture at New Haven, Millikan said, in part: "Today, we can still look out with a sense of wonder and reverence upon the fundamental elements of the physical world as they have been revealed to us in the twentieth century. We know now that the childish mechanical conceptions of the nineteenth century are grotesquely inadequate. We have now no one consistent scheme of interpretation of physical phenomena and we have become wise enough to see and to admit that we have none. We have learned to work with new enthusiasm and hope and new joy, because there is still so much that we do not understand; because we have actually succeeded in our life-times in finding more new relations in physics than had come to light in all preceding ages put together; and because the stream of discovery, as yet, shows no sign of abatement." J. H. G.

A Modified Form of True-False Test. H. Y. MCCLUSKY AND F. D. CURTIS. *Gen. Sci. Quart.*, **11**, 112–6 (Jan., 1927).—This kind of test appeared about seven years ago. It has these objections, (1) It facilitates the "proclivity to borrow from one's neighbor;" (2) it is unsatisfactory "as an instrument for diagnosing special individual difficulties;" and, (3) it permits more or less successful guessing of the correct response.

The authors have made several investigations with a modified true-false test, at the University of Michigan High School, using five classes of general science and biology. Fifty true-false items were prepared for each class. Details of the tests and results follow.

The investigation furnished evidence in support of the following conclusions: (1) The modified form takes more time to administer than the true-false; (2) the modified form possesses a greater usefulness in homogeneous grouping for drill upon certain units of work than does the true-false; the modified form, moreover, is superior to the true-false for the diagnosis of individual and class difficulties and weaknesses; (3) the modified form is a better power test than the true-false; (4) it is more reliable than the true-false; (5) it is more difficult than the true-false; (6) it tends to eliminate whatever elements of guessing may be functioning in the true-false. J. H. G.

Local Activities and Opportunities

Cornell University. The department of chemistry at Cornell will offer instruction in chemical microscopy during the coming Summer Session of the University. The equipment of the Baker Laboratory is unique in this field and affords excellent facilities for the study of various microscopic methods as applied to chemical problems.

The introductory course will cover the the use of the microscope and its accessories, microscopic measurements and quantitative methods, crystal studies, micro-manipulation, refractive index determinations, and examination of textile and paper fibers. A course in microscopic qualitative analysis, including the reactions of the commoner metals and acids, will also be given. Both of these courses will be the full equivalent of those given during the regular college year; they may be taken separately or together, or other work in the department may be carried on, according to the needs of the student.

The Summer Session opens July 5th and continues for six weeks, but persons not desiring university credit may arrange to cover, in a shorter period, those portions of the work most suited to their special needs. Any inquiries should be addressed to Dr. C. W. Mason, who will have charge of the courses.

Wisconsin Section, A. C. S. The one hundred fifty-third regular meeting of the Wisconsin Section of the American Chemical Society was held at the University of Wisconsin on February 7th. An illustrated lecture was given by Dr. Fritz Paneth on "Cosmic Chemistry." Dr. Paneth is professor of inorganic chemistry at the University of Berlin and nonresident lecturer in chemistry at Cornell University. His appearance before the Wisconsin Section was made possible through the coöperation of the Committee on Lectures and Convocations of the University of Wisconsin.

Lexington Section, A. C. S. The one hundred seventeenth regular meeting of the Lexington Section of the American Chemical Society was held at the University of Kentucky on February 9th. Prof. H. Shipley Fry addressed the Section on "The Oxidizing Action of Alkali Hydroxides upon Carbon Compounds."

University of California, Southern Branch. Dr. W. R. Crowell, assistant professor of chemistry at the University of California, Southern Branch, will be absent on sabbatical leave during the spring semester of 1927. Dr. Crowell will carry out investigations with Professor A. A. Noyes at the California Institute of Technology on the vapor pressure of borax and the chemistry of some of the rarer elements.

University of Florida. The contract has just been let for the furniture for the new Chemistry-Pharmacy building, construction on which is being rapidly pushed. Delivery of the new furniture will be made in June, and the building will be fully equipped and ready for the opening of the fall semester.

Prof. R. C. Goodwin, of the chemistry department, addressed the Marion County Teachers' Association at their regular monthly meeting. He spoke on "Some Problems of Rural Education."

Students majoring in chemical engineering have just returned from the annual inspection trip to the various manufacturing plants in and around Jacksonville. They were accompanied by Prof. V. T. Jackson of the department.

The fourteenth meeting of the Florida Section, A. C. S., was held in the Engineering College lecture room of the

University on Saturday evening, February 19th. Dr. F. E. Poindexter, professor of physics, read a paper entitled, "An Hypothesis of Matter and Radiation."

University of Chicago. Assistant Professor Ethel M. Terry-McCoy has resigned from the staff of the department of chemistry, the resignation to take effect at the end of the Winter Quarter. Dr. Terry-McCoy was Assistant, 1908–1910; Associate, 1910–1913; Instructor, 1913–1918. Since 1918 she has been assistant professor in charge of the teaching of general chemistry to students who have entered the University without high-school chemistry, and in that capacity was co-author of the McCoy and Terry text, "Introduction to General Chemistry," which has met with a large measure of success. Dr. Terry-McCoy's field of research interest has been in physico-organic chemistry, principally in the field of catalysis.

Miss Edna Shaver and Miss Nora Iddings have received appointments in chemistry at the Chicago Normal School.

Kansas Association. The third annual meeting of the Kansas Association of Chemistry, Physics, and General Science Teachers was held at Topeka, Kansas, on February 5, 1927, at the time of the meeting of the Council of Administration. This association is composed of the college teachers and also the high-school teachers of Kansas.

In order to get something of a unified program for the science teachers of the state, the chairmen of the round tables of each section of the Kansas Association were placed upon the program to discuss the program they expect to use at the meeting of their round tables next fall. The program in this way gave an opportunity for helpful suggestions from both groups of teachers. Inspiring and helpful addresses were given by President Lewis, Dean Schwegler, and Dr. Xan. President Lewis was a science teacher before becoming President. A brief resumé of the three addresses will be published and mailed to the sience teachers of the state.

The attendance at the meeting was good. Most of the colleges of the state were represented and also many of the high-school teachers of chemistry and physics attended.

Those who attended felt that a worthwhile program was given and that the opportunity of becoming better acquainted was furnished through this meeting.

Ohio State University. The Seventh Annual Educational Conference will be held on April 7, 8, 9, 1927. The program for the Section of Non-Biological Sciences follows:

Friday, April 8, 1927

Morning Session—9.30 o'clock

1. "The Use of Graphics in Teaching General Chemistry," by Professor J. E. Day, the Ohio State University.

2. "Measurement of Chemical Attitude and Attainment of Freshmen in American Colleges," by Professor Jacob Cornog, the University of Iowa.

3. "National Research Institute of Chemical Education," by Professor Neil E. Gordon, Editor of JOURNAL OF CHEMICAL EDUCATION, the University of Maryland.

4. Demonstration of New Experiments. All teachers of the non-biological sciences are cordially invited to present by actual demonstrations any new experiments which they may have devised in their teaching. This exhibition is also intended to include charts and models which have proved to be helpful in the presentation of these sciences.

5. Appropriate announcements will be made at the morning session with reference to a group luncheon.

Afternoon Session—2.00 o'clock

1. "Recent Ether-Drift Experiments and Their Interpretation," by Professor Dayton C. Miller, Case School of Applied Science.

2. "Recently Discovered Elements," by Professor B. S. Hopkins, The University of Illinois.

Recent Books

Handbook of Organic Analysis, Qualitative and Quantitative. HANS THACHER CLARKE, D.Sc., F.I.C. 4th edition. Longmans, Green & Co., New York. Edward Arnold & Co., London, 1926. xii + 363 pp. 23 figures. 12 × 18 cm. $3.00.

Chapter I, 25 pp., is devoted to the preliminary examination of the substance for its purity and to finding the elements present. In Chapter II, 73 pp., all the common classes of organic compounds are taken up and their characteristic reactions described, particularly those that are useful in their detection. Chapter III, gives briefly a plan for separating compounds of different classes. Chapter IV, 187 pp., the most important part of the book, is a classified table of a thousand of the most important organic compounds. The compounds of a class, such as aldehydes or alcohols, are arranged either according to their boiling points or their melting points. Under each compound are given its properties, its characteristic reactions, and the melting points of its derivatives.

Chapter V, 23 pp., is on the quantitative determination of the elements and Chapter VI, 19 pp., on the quantitative estimation of groups. Chapter VII, 19 pp., is devoted to methods of determining physical properties. There is an index of the compounds covered besides the general index.

This is an improved edition of a useful book. The identification of organic compounds is interesting and useful to the student as it gives full scope to his ingenuity and develops his acquaintance with the properties and reactions of organic compounds. In this book the material is logically arranged and the subject is well developed. Recent methods are given and much useful information is brought together. It will be valuable as a laboratory manual for students and as a handy reference volume for research workers.

E. EMMETT REID

Applied X-Rays. GEORGE L. CLARK, Ph.D., Assistant Professor of Applied Chemical Research, Massachusetts Institute of Technology. McGraw-Hill Book Co., Inc., New York City. First edition. xiii + 255 pp. 99 illustrations. 14.5 × 23 cm. $4.00.

The industrial executive and his laboratory director frequently inquire whether X-rays will be useful in connection with their problems. It is the purpose of this book to tell what X-rays are and to show what they have been made to do so far. The book is exceedingly well written from this point of view, and gives not only a clear statement of the fundamental principles and their application to industrial problems, but also many practical suggestions as to the various types of equipment and where they may be obtained.

Metallographers in industry will find the book invaluable. Colloid chemists will find Chapter 19 highly suggestive. The book is not intended as a class-room text and probably could not be used successfully as such, but every class in physics or physical chemistry should have access to it as a reference book. The high-school teacher of physics or chemistry who reads it thoroughly can hardly help being a better and more inspiring teacher. He will find himself with a new stock of illustrative material which will be useful during the whole school year. Most college teachers of physical chemistry cannot afford to be without it, and the teacher of metallography will find the book very much worthwhile in his efforts to keep up-to-date.

WHEELER P. DAVEY

A Collection of Chemical Lecture Experiments. H. F. DAVISON. The Chemical Catalog Co., Inc., New York City, 1926. First edition. 139 pp. 23 figures. 12.5 × 19 cm. $2.50 net.

In a preliminary note to the reader this little book is gracefully dedicated by L. A. Bigelow to the Teaching Profession as the last work of one who was called only too suddenly from our ranks.

Those who were fortunate enough to hear Prof. Davison's paper on "The Art of Lecture Table Demonstrating," delivered before the Division of Chemical Education at the recent Baltimore meeting of the American Chemical Society, will be particularly interested in the introductory chapter which bears the same title. In it the author, a very able demonstrator himself, has given a very clear exposition of the fundamental rules which he believes must be observed.

There follow descriptions of 69 experiments, grouped in the index under the titles: Gases (5), Combustion and Oxidation (12), Hydrolysis (4), Colloidal Chemistry (8), The Atmosphere (4), Solubility and Solution (7), Ammonia and Its Compounds (10), Time Reactions (3), Activity of the Elements (6), and Miscellaneous (11).

The author has limited himself almost wholly to experiments designed for a relatively small class in general chemistry and, as he announces in the preface, does not attempt to make the list complete.

Drawings of set-ups are abundant and well executed. Some of the experiments admit of multiple application to which attention is not called. For example, Experiment 45, "The Time Reaction of Iodic Acid," could serve also to illustrate the preparation of iodine, the oxidizing power of iodic acid and the effect of temperature on the speed of chemical action.

The simplicity of the apparatus and the minuteness of the directions indicate that each experiment must have received careful preliminary testing. Included in the list are original devices as well as unique modifications of time-honored lecture experiments.

Although explanations of the principles involved and references to the original literature are frequently missing, this collection of experiments should be in the hands of every teacher of general chemistry.

R. A. BAKER

The Hydrous Oxides. HARRY B. WEISER. McGraw-Hill Book Co., Inc., New York City, 1926. x + 452 pp. 14 × 20 cm. $5.00.

The literature on hydrous oxide gels and sols is voluminous and has been unavailable in compact form until the appearance of Prof. Weiser's unique book. Following a short but comprehensive review of the theories of gel structure, the properties of precipitates, suspensions, and sols of the following elements are described—iron, chromium, aluminum, gallium, indium, thallium, copper, cobalt, nickel, silver, gold, beryllium, magnesium, zinc, cadmium, mercury, silicon, germanium, tin, lead, titanium, zirconium, thorium, vanadium, columbium, tantalum, antimony, bismuth, molybdenum, tungsten, uranium, manganese, the rare earths, and the platinum family. There are also chapters on tanning, mordants, water purification, cement, and soil.

Dr. Weiser has undertaken a difficult task and has produced a valuable contribution to chemical literature. He has given not merely a "scissors and paste" compilation but has discussed his subject critically. His point of view is that of the mechanistic school of colloids. Colloids are shown to be small particles of matter possessing little or no chemical reactivity; they merely adsorb. It is a pity that the conception of "hydrous oxide" colloids, as pure oxides which adsorb, or are "peptized" by electrolytes or their ions, should be so vigorously defended by the author against such good physico-chemical evidence as composition of the electrophoresced micelles and electrode potential measurements which show

that they are far from being pure oxides plus adsorbed ions. For example, Pauli's measurements have well verified Duclaux's opinion that the dispersed phase in hydrous iron oxide sol made by hydrolysis of ferric chloride, or by peptization of precipitated hydrous ferric oxide by hydrochloric acid, is a very complex aggregate of what might be termed ferric oxychloride, or of a series of ferric oxychlorides. If this view is too radical then, criticizing from another angle, ferric oxide hydrosol can hardly consist of iron oxide particles which have adsorbed the hydrogen ions of the peptizing hydrochloric acid, or the ferric ions of the peptizing ferric chloride, because this simple picture leaves the chloride ions free in solution. It has been found (Pauli) that the actual chloride-ion concentration of such a sol may be vanishingly small although containing a large proportion of chloride. Furthermore, the "colloid" electrically deposited at the cathode has been shown to contain a considerable amount of chloride.

An example of Weiser's resistance to the concept of chemical reactivity of a colloidally dispersed phase is found on pages 67–68 in the discussion of the so-called adsorption of arsenious acid by hydrous ferric oxide. The convincing calculation of Reychler which showed Biltz's adsorption constant to be the hydrolytic equilibrium constant for the hydrolysis of ferric arsenite is ignored.

In a criticism of the chemical theory of mutual precipitation of hydrosols Prof. Weiser admits that the mutual reaction between negative sulfur and negative arsenious sulfide sols is chemical in nature, yet, in connection with his criticism of similar evidence for oppositely charged sols, he makes the following statement (page 64), "Such an interpretation of the mechanism of the mutual precipitation process would not account for the repeated observation of mutual precipitation of sols where interaction between the peptizing agents is impossible or improbable." The author stops here. Such a statement would be strengthened by citation of a specific example. None is cited.

Evidently for the purpose of effectively brushing aside quantitative chemical evidence, the author states—"Thus, to obtain data to support a purely chemical mechanism involving the stabilizing agents, it seems necessary to choose the experimental conditions to fit the case." The reviewer fails to see the justice of this criticism since in all quantitative determinations, the conditions must be chosen to fit the case as, for example, in the precipitation of magnesium ammonium phosphate.

The chapter on tanning hardly belongs in this book because hydrous oxides do not tan. For one thing they cannot diffuse through the compact hide protein structure. This is proper *colloidal* behavior. In this chapter, incidental to the resistance to a chemical point of view, the author compares curves of Thomas and Kelly on combinations between hide substance and chromium with curves for the adsorption of acetic acid from toluene solution by charcoal. Thomas and Kelly's "adsorption" curve has been erased from their published diagram as reproduced in Fig. 21, while their chrome-collagen composition curve, obtained by an entirely different technic, is erroneously reproduced as their "adsorption" curve. The deleted "adsorption" curve was identical in character to the acetic acid-toluene curve cited in argument in Fig. 22. This missing curve proved the futility of the common practice of measuring adsorption by the "by-difference" technic in certain systems.

While the reviewer takes issue with the author in some instances, he would emphasize the fact that Weiser's book is a very useful discussion of a field of inorganic chemistry that has been neglected by writers of books. It is filled with interesting information which deserves wide circulation.

ARTHUR W. THOMAS

Electricity and the Structure of Matter. L. SOUTHERNS, M.A., B.Sc. Oxford University Press, London, 1925. 128 pp. 12 × 18.5 cm. 34 illustrations. $1.00 net.

This little book is one of a popular series, *The World's Manuals*, designed to provide a simple treatment of modern scientific accomplishments. From the present volume the intelligent layman will be able to obtain a general idea of the scientific basis for many inventions and devices now so commonly used and discussed. The presentation is lucid and, in places, touched with an element of humor or human interest that enhances the value of the book for the accomplishment of its purpose.

Chapter I is a general historical survey of early developments in electricity and magnetism, including many of the subjects usually treated in the most elementary courses in physics. The remaining chapters are as follows: Electric Currents and Their Applications; Radioactivity; Atomic Architecture; Electromagnetic Waves; Atomic Aggregates. There is appended a brief glossary of the most important terms and a list of books suggested for further study.

The book may well be commended to the general reader who has an interest in scientific affairs.

G. H. CARTLEDGE

The Safe Chem Book for Boys and Girls. MAX SMALL, B.A., M.A. The Safe Chem Set Company, New Haven, Connecticut, 1926. 40 pp. 15 × 23 cm. 12 illustrations. Sold in conjunction with Safe Chem Sets.

The secondary title states that this pamphlet contains "complete directions for performing chemical experiments and tricks at home, guaranteed to be safe and harmless." The eye is immediately caught by the blocked cover border containing the names, alchemistic signs, and modern symbols of eight common elements.

The spirit of the book is well shown by the heading of the first page of the text: "Boys and Girls, the thrill of the alchemist, the charm of the magician and the skill of the chemist may be yours."

The experiments are preceded by two pages of general directions on cleanliness, orderliness, and care in using chemicals such as are found in many laboratory manuals but modified for the use of pupils who are to amplify the chemicals in the Safe Chem Set with such substances as may be found in the kitchen or medicine cabinet.

Directions are given for 130 experiments, most of which are similar to those found in many laboratory manuals, particularly of the household chemistry type. They are subdivided as follows: (1) Examples of Chemical Change; (2) Metals, Metallurgy, Elements, Compounds; (3) Acids and Bases; (4) Salts; (5) Gases; (6) Tricks and Magic; (7) Inks; (8) Analytical Chemistry; (9) Chemistry and the Home; (10) Photography; and (11) Industrial Chemistry.

It seems to the reviewer that many of the experiments are designed to excite wonder rather than to impart an understanding of chemical reactions. For instance, "Experiment 1, A Remarkable Color Change" is covered in three lines: "Pour a little ferric chloride into a test tube, then add a few drops of potassium thiocyanate. The blood-red color obtained is used by chemists to detect the presence of iron compounds in water." Many chemicals used in the experiments must remain simply names to the pupil, due probably to the age of the child and the purpose of the pamphlet. It is good, however, to see that most of the really dangerous experiments have been omitted.

Such titles as "Boiling without Heat" for a case of evolving carbon dioxide from a carbonate and an acid, and "Changing Iron to Copper" for a replacement reaction seem misleading. Probably the wording is chosen to catch the eye.

The chapter on tricks and magic is interesting; *e. g.*, "Red paper is placed in

a red solution and comes out Blue," and "Blue paper is put in a blue solution and comes out Red," and "A Saint Patrick's Day Trick."

Eighteen simple experiments giving tests for ten bases and three acid radicals finish up with "Testing an Unknown." It seems doubtful to award a "Diploma as Amateur Analytical Chemist" for performing these eighteen experiments and doing one unknown correctly.

The pamphlet will doubtless serve well the purpose for which it was written. A commendable feature on the last page is a list of 15 well-known chemistry books of a popular nature. These should lead the student later to a regular course in chemistry.

WILHELM SEGERBLOM

Electro-organic Chemistry. C. J. BROCKMAN, Associate Professor of Chemistry, University of Georgia, John Wiley and Sons, Inc., New York City, 1926. xi + 381 pp. 15 × 23 cm. $5.00 net.

Professor Brockman has done an excellent piece of work in collecting together and systematizing the bewildering mass of information on the oxidation and reduction of organic compounds at electrodes during the process of electrolysis. The book deals mainly with the preparative conditions for obtaining high yields and gives copious references to the literature.

We learn (p. 17) that "The oxidation of aliphatic compounds often goes to completion, that is to water and carbon dioxide. On the other hand, the aromatic compounds have a great tendency to form phenolic compounds which form condensation products of a resinous nature. In a great many cases the formation of resins is a serious handicap to the purification of the final products. When pyridine is used as the solvent this trouble is usually encountered."

Until a very few years ago this whole branch of chemistry consisted of qualitative or semi-qualitative observations and the attempts to put the subject on a truly scientific basis were not very successful; extension of potentiometric methods to the study of organic oxidation–reduction systems by Clark, Biilmann, La Mer, Conant, and others, gives a more truly scientific basis to this subject and a study of their work should precede a study of the extremely large body of experimental observations.

F. O. RICE

Exercises in General Chemistry and Qualitative Analysis. HORACE G. DEMING AND SAUL B. ARENSON. John Wiley and Sons, New York City, 1926. Second edition, revised. xii + 282 pp. 13.5 × 21.5 cm. $1.80 net.

The authors have rearranged the order of topics to conform to that in the revised edition of Deming's "General Chemistry." Several new experiments—especially those on substances and their properties, physical and chemical change, and oxidation-reduction reactions—are welcome additions. A few quantitative exercises have been retained, although the authors "are of the opinion that quantitative work in an elementary course often consumes time that were better spent in the accumulation of useful and necessary qualitative information." The section on qualitative analysis has been definitely improved, as the result of experience gained in two years of use in many schools.

H. H. LLOYD

Qualitative Analysis. WILLIAM C. COOPER, M.S., Ph.D. Professor of Chemistry, De Paul University, Chicago, Ill., World Book Co., Yonkers-on-Hudson, New York, 1926. viii + 142 pp. 13.5 × 20 cm. $1.52.

As is customary the "bases" are considered first, then the "acids," and finally equations are given in the back portion of the book, some being balanced while others are not. No "preliminary" work is included.

The text in general is poorly written,

not only from a pedagogic standpoint, but also from a scientific point of view.

The author "presupposes a general course in inorganic chemistry in which the theory of equations, oxidation and reduction and the various problems in chemistry have been thoroughly taught." As a result of the reviewer's teaching experience in three state universities he is of the opinion that such an assumption is anything but justified. A course in inorganic chemistry is so "general" that the average student does not learn any of the principles thoroughly—time will not permit of such treatment. It is in the realm of qualitative analysis that just those fundamental topics, so superficially treated in inorganic chemistry, should be re-taught and "driven home" by repeated *application*. It is an ill contention that argues for the mastery of the ionic theory, mass law, and equations on the part of a freshman. The subject of qualitative analysis affords such a wonderful opportunity for *acquiring* and *clinching* a knowledge of these principles that they should never be omitted unless it is desired to give only a "surface exposure" to the course. It is unfortunate that the subject is only too often thus treated in many of our colleges and universities.

The reviewer agrees with the author that the time usually allotted is insufficient for the best and most thorough treatment of the subject. The theoretical content of the course has increased considerably during the last two decades but in most institutions the time allowed has not been increased. Despite this fact some preliminary work coupled with the treatment and application of fundamental principles should be included, or it were better to omit the course entirely. It is utterly impossible to teach a student to be scientific through the medium of a text such as the one under examination, *unless* it is considerably supplemented by much pertinent material on the part of the instructor.

Hints at the ionic theory are very noticeably absent. Regardless of whether the author doubts the validity of the theory or not, he is certainly missing an opportunity to use expressive language. Ionic terminology connotes many facts that are not implied when other language is employed.

The "prose" form of writing a book on qualitative analysis is always objectionable. If the schemes of analysis proper were written in tabular form in the body of the book, even though this were done by way of repetition in a more concise manner, it would at least offer the student some degree of relief and escape from the monotonous method of presentation.

Awkward English is employed at times. For instance, on page 33, we find this sentence: "The best course to follow is always to test for arsenic the residue left after filtering the antimony and tin." On page 21 we find "supernatent" and on page 29 "oxichloride." From the standpoint of orthography these words are quite unorthodox.

On page 37 there also appear "sulfocyanide" and "aluminum." Although there is no such thing among chemists as "official spelling," yet it would be well if writers of texts would lean toward the official spelling of the American Chemical Society.

Such expressions as "mercury ammonium chloride" and "silver ammonium chloride" and the ambiguous term "mercury chloride" are apt to jar the reader a little.

On page 25 the following paragraph appears: "If the solution is made acid with nitric acid, the sulfides will re-dissolve as fast as they are formed." Again we encounter on page 88 a clause which runs thus: "may dissolve the precipitate of calcium carbonate as fast as it is formed." In both these cases the author is probably trying to say that no precipitate forms under the existing conditions, but he resorts to linguistic monstrosities to do so.

On page 25 we find: "The sulfides of the metals of Group II are insoluble in the hydrochloric solution, while the sulfides

of the metals of the succeeding groups are soluble and therefore do not precipitate." This is a very antiquated way of stating the case. Speaking in terms of the "solubility product" and "common ion effect" concepts would be more in keeping with modern expression.

In the test for antimony given on page 34 the author refers to the use of platinum as a "catalytic agent." It is rather "electrolytic" in its function, since it assists in the release of positive zinc ions from the 'Helmholtz double layer" *at* the surface of the zinc.

The technic is bad in places. For instance, on page 22 the use of a beaker is prescribed where a test-tube would be more serviceable in the interest of economy.

In the above criticism the reviewer has not mentioned all the weak points contained in this work, but referred to only scattered "samples."

To sum it all up, the reviewer can see no place for this book in the hands of a novice pursuing a modern course in qualitative analysis.

EDWARD X. ANDERSON

Cargoes and Harvests. DONALD CULROSS PEATTIE. D. Appleton & Co., 1926. 311 pp. 13.25 × 20.5 cm. $2.50.

As the publishers announce, this is a story of romantic exploration and the adventurous discovery of those plants which above all others figure in the existence of mankind. "The discovery and exploration of every day commodities has a history as colorful as any romantic tale. Tea, cocoa, camphor, tobacco, and cotton have histories of difficulties, strife, invention, famine, and exploration that make fascinating reading."

These are large claims and yet they are not without foundation. The author has indeed a lively imagination and uses it well as he writes chapters on Plant Power, The Spices of Ind, Quinine, The Age of Rubber, The Five O'Clock Tea, The Vanishing Vegetable Dyes, Camphor, The Potato, Bread Fruit, The Poppy, Tobacco, Cotton, and The Tree of the Leper. Quaint maps, decorated in the old style, add to the pleasing appearance of the book. The references at the end of the chapters are also of some value.

If stimulating the imagination of a high-school student is desirable, and none denies that, then this book has a place in the high-school library. There is not a great deal of chemistry in it, although chemists must be interested in the story of logwood black. This dye, we are told, was first brought from tropical America and because of its merit at once aroused opposition from the old-fashined dye workers of England. Actually during the reign of Queen Elizabeth a British law was passed ordering that "whereas the clothes dyed with logwood are solde and uttered to the great deceit of the Queenes loved subjects be it enacted by the Queene, our Soveraygn Ladie, that all such Logwood. . . . . shall be openly burned by the authorities." Indigo, too, had to force out the inferior blue dye obtained from woad. Woad growers persuaded Henry IV of France to prevent the use of indigo and to get Emporer Rudolph to banish it from Germany as "a prejudicial, cheating, corrosive, devouring and diabolical substance." The penalty for possessing indigo was death, dishonor, and confiscation of property.

Had the author been a chemist he would not have made the misleading statement on page 133 that "from camphor is derived celluloid, which, combined with nitric acid, produces the modern high explosives." In the Rubber Chapter there was little or nothing said of vulcanization. But this is, after all, a book on plants and possibly we should not ask for much, or for very accurate chemistry. In its own field the book has merit.

HARRY N. HOLMES

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Kansas	4%	South Dakota	10%
Kentucky	−2%	Tennessee	0%
Louisiana	24%	Texas	35%
Maine	7%	Utah	−4%
Maryland	140%	Vermont	33%
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